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CHIEF JOSEPH AND THE NEZ PERCÉ WAR.

ONE of the most important monographs which has ever been published by the Bureau of Ethnology is "The Ghost Dance Religion and the Sioux Outbreak of 1890," by James Mooney. This is a splendid contribution to American ethnology, and by permission of the Director of the Bureau we are enabled to present an illustration of Chief Joseph and give some account of his masterly campaign and retreat.

Many years ago we heard of a "dreamer prophet" on the Columbia called Smohalla, who had become a thorn in the flesh of the Indian agents in that quarter and was reported to be organizing among the Indians a new religion which taught the destruction of the whites and resistance to the government. It appeared that Smohalla and his followers, numbering perhaps about two thousand Indians of various tribes along the Columbia and Eastern Washington and Oregon, had never made treaties giving up any of their land, and claimed the right to take salmon in the streams and occupy the prairies in the way they desired without being molested. They stoutly objected to going upon any Indian reservation. There is no doubt that justice and common sense were on the side of the Indians. We first hear officially of Smohalla and his people from A. B. Meacham, Superintendent of Indian Affairs in Oregon. He states, in September, 1870, that "one serious drawback to the adoption of the white man's road was the existence among the Indians of Oregon of a peculiar religion called Smokeller or Dreamers, the chief doctrine of which is that the red man is again to rule the country, and this sometimes leads to rebellion against authority." In 1872 the Smohalla's followers along the Columbia were reported to number two thousand, and his apostles were represented as constantly traveling from one reservation to another to win over new converts to his teachings. We hear little more of Smohalla and his doctrines for several years, until attention was again attracted to Indian affairs in the Northwest by a growing dissatisfaction which culminated in the Nez Percé war of 1877.

The Nez Percés, especially those who acknowledged the leadership of Chief Joseph, were largely under the influence of the Dreamer prophets, and there was reason to believe that an uprising inaugurated by so prominent a tribe would involve all the smaller tribes in sympathy with the general Indian belief. As soon, therefore, as it became evident that matters were approaching a crisis, a commission, of which Gen. O. O. Howard was chief, was appointed to make some peaceable arrangement. The commissioner met Smohalla and his principal men at Wallula, Washington Territory, on April 23, 1877, and as a result of the council then held, these non-treaty tribes, although insisting as strongly as ever on their rights to live undisturbed in their own country, yet refrained from taking part in the war which broke out a few weeks later.

The Nez Percé war of 1877 originated in the unauthorized intrusion of lawless whites on lands which the Indians claimed was theirs by virtue of occupancy from time immemorial. By a treaty made in 1863, the Nez Percés were restricted within narrow limits. By this treaty the Wallowa Valley, in Northeastern Oregon, the ancestral home of the part of the tribe under the leadership of Chief Joseph, was taken from the Indians. This portion of the tribe, however, refused to have part in the negotiation, and Chief Joseph and his band, ignoring the treaty of 1863, continued to claim the Wallowa Valley, where he was permitted to roam without restraint until the encroachment of white settlers induced the government to take some definite action respecting this band of non-treaty Nez Percés. About this time the tribe numbered about 2,800, of whom 500 acknowledged Joseph as a chief.

Collisions between the whites and the Indians in the valley became more frequent and one of Joseph's band had been killed, when a commission was appointed in 1876 to induce the Indians to give up the Wallowa Valley and remove to the Lapwai reservation in Idaho. Joseph still refusing to remove, the matter was turned over to General Howard, and on May 3, 1877, he held a ceremonial council with Joseph and his followers at Fort Lapwai. At this conference, in which the ceremonial approach was probably in accord with the ritual teachings of the Dreamer religion, the principal Dreamer priest of Joseph's band acted as spokesman for the Indians, and insisted according to the Smohalla doctrine that the earth was his mother and she should not be disturbed by hoe or plow and that men should subsist by the spontaneous productions of nature and that the sovereignty of the earth could not be sold or given away. Continuing, he asserted, "We never have made any trade. Part of the Indians gave up their land. I never did. The earth is part of my body. I never gave up the earth; so long as the earth keeps me I want to be left alone." General Howard finally ordered him under arrest, after which the Indians agreed to go on a reservation by June 14. A few days later councils were held with Smohalla and his people and with Moses, another noted chief. Both chiefs, representing at least about 500 warriors, disclaimed any hostile intentions and agreed to go on reservation. Parties under Joseph and other leading chiefs then went out to select suitable locations for reservations, Joseph and his band deciding in favor of the Lapwai Valley. Everything was moving smoothly toward a speedy and peaceful settlement, and the commissions had already reported the successful accomplishment of the work, but a single act of lawless violence undid the labor of weeks and precipitated a bloody war. One of Joseph's band had been murdered by whites some time before, but the Indians had remained quiet. Now while the Nez Percés were gathering up their stock to remove to the reservation selected, a band of white robbers attacked them, ran off with the cattle and killed one of the party in charge. Joseph could no longer restrain his warriors, and on June 13, 1877, the Nez Percés attacked the neighboring settlement on White Bird Creek, Idaho, and killed twenty-one persons. The troops under Howard were ordered out. The first fight occurred on June 17, at Hangman's Creek, and resulted in the loss of thirty-four soldiers. Then came another on July 4, with a loss of thirteen more, and on July 12 another encounter by troops under General Howard himself, in which eleven soldiers were killed and twenty-seven were wounded.

CHIEF JOSEPH.

Then began one of the most remarkable exhibitions of generalship in the history of our Indian wars, a retreat worthy to be remembered with that of the storied ten thousand. With hardly a hundred warriors, and impeded by more than three hundred and fifty helpless women and children, with General Howard behind, with Colonel (now General) Miles in front, and with Colonel Sturgis and the Crow scouts coming down upon his flank, Chief Joseph led his little band up the Clearwater and across the mountains into Montana, turning at Big Hole Pass long enough to beat back his pursuers with a loss of sixty men; then on by devious mountain trails southeast into Yellowstone Park, where he again turned on Howard and drove him back; then he went into Wyoming and north to Montana again, hoping to find safety on Canadian soil, until intercepted in the neighborhood of the Yellowstone by Colonel Sturgis in front with fresh troops and a detachment of Crow scouts, with whom they sustained two more encounters, this time with a heavy loss of men and horses to themselves. This handful of starving and worn-out warriors, now reduced to scarcely fifty able-bodied men, carrying their wounded and helpless families, crossed the Missouri and entered the Pearpaw Mountains; but new enemies were on their trail, and at last, when within fifty miles of the land of refuge, Colonel Miles, with a fresh army, cut off their retreat by a decisive blow, capturing more than half their horses, killing a number of the band, including Joseph's brother and the noted chief Looking Glass, and wounding forty others.

Forced either to surrender or to abandon the helpless wounded and the women and children, Joseph chose to surrender to Colonel Miles on October 5, 1877, after a masterly retreat of more than a thousand miles. He claimed that this was "a conditional surrender with a distinct promise that he should go back to Idaho in the spring." General Sheridan, ignoring the promises made on the battlefield, ordered the hostiles to Leavenworth, and seven years passed before the promise was kept, and in the meantime the band had been reduced by disease and death, in Indian Territory, from 450 to about 280. Chief Joseph is noted for his high character, and he took part in the parade at the opening of the Grant tomb, at Riverside Park, on April 27, 1897.

To Polish the Bright Parts of Sewing and Other Machines.—We find the following in the Drogisten Zeitung: Mix together 10 parts of oil of turpentine, 20 parts of stearin oil and 30 parts of animal charcoal in the finest subdivision, and add sufficient alcohol to strongly dilute the material. With a hair pencil apply the liquid to the parts which it is desired to clean. Let stand until the alcohol evaporates, and then with a cloth charged with dry charcoal (animal) and jewelers' rouge go over the parts, rubbing not too strongly. Finish by rubbing with a cloth or chamois.

CAMILLE FLAMMARION.

A STUDY.

IT is not to many that the world, chary of laurels, concedes the right to be successful in more than one capacity. We don't hear of Swinburne as a swimmer, nor of Max Nordau as a dramatist. Camille Flammarion has achieved great things both as an astronomer and a writer of books, and has therefore paid the almost inevitable penalty of publicity. The French savant is, as a rule, a man who avoids all publicity. "You should not judge the Parisians," said Alphonse Daudet to me on one occasion, "by the people you see and hear about. The true workers of Paris are below the surface. You would not attribute the speed and power of a transatlantic steamer to the fashionable loungers on the promenade deck." How many people had heard of Chevreul, until the circumstances of his centenary attracted the attention of the vulgar, or of Pasteur, until one of the minor results of his life's work set human egotism agog. To how many is, to-day, familiar the name of Henri Moissan, the true Diamond King, of Berthelot, apart from political mountebankery, or of the hundred and one great scientists of France, who, in dignified and self-sought obscurity and retirement, are working for a chattering world?

Camille Flammarion is an exception to the rule. He is much sought after. Not an atmospheric disturbance anywhere, but an interview with or an appreciation by Camille Flammarion follows. He has rendered many services to science. It was in 1873, for instance, that he contributed his important observations and drawings of the planet Mars to the Academy of Sciences, and in 1877 that he finished his "Catalogue of Double Stars," which has since become a classic in every observatory throughout the civilized world.

His present bent will be perhaps best indicated by quoting a conversation which I had with Madame Flammarion, in their apartment in the Rue Cassini.

"He is," she said, "an extremely methodical man. He gets up regularly every morning at seven o'clock and spends time over his toilet. Savants, as a rule, are not very tidy, but Flammarion is an exception to the rule. At a quarter to eight every morning he has his first breakfast. From eight to twelve he writes. At noon he has his déjeuner. From one to two he receives, and as he knows everybody in Paris, and as he is constantly being consulted on all sorts of questions by Parisian reporters, he is usually kept very busy during this hour. From two to three he dictates letters to me, and as he receives thousands of letters from all parts of the world, especially when anything new in the branch of astronomical science is occupying public attention, my time is fully occupied. At three o'clock he goes out and attends to his business as editor of the monthly magazine he has founded, The Monthly Review of Astronomy, founded in 1882. It has never paid its way, but, as it is the only serial publication in France devoted to the science of astronomy, he is proud to have created it."

"The rest of the afternoon," continued his wife, "is devoted by Flammarion to his duties as member of various societies. He is back home again at half past seven, when he has his dinner, and spends the evening in reading. He is a great reader and tries to keep himself au courant with all that is said on the important topics of the day. Of course what I have been describing is his winter programme. It is in the summer, when we are down at Juvisy, that he continues his studies in astronomy, that is to say from May to November. There the programme of his daily life is somewhat different, for on fine nights he sometimes stays up at his observatory till a very early hour in the morning. But as here, so at Juvisy, he is very regular in his habits."

Camille Flammarion appears to have turned his attention to the science of astronomy at a very early date in his career, for before he was sixteen years old he had written, and published, a work entitled "The Cosmogony of the Universe," and by the time he was twenty his "The Plurality of Inhabited Worlds" had already appeared.

It is true that, even as a child, he was distinguished as precocious, and that he is, in the best sense of the word, a self-made man. The child of humble villagers in the department of la Haute Marne (he was born in 1842), he could read and write when he was only four years old, and at the age of seven had already been publicly commended for his work in an examination at school. As a child also and from the first he took a keen interest in star-gazing. "I shall never forget," he told me, "with what joy I carried home the first telescope that I was able to purchase. It was a miserable one. I had bought it at a second hand shop, but I think that it gave me more pleasure than any of the magnificent instruments which have since been placed at my disposal." He was a splendid worker—indeed to-day at the age of fifty-five his energy seems to be in nowise diminished—and, though apprenticed at the age of fifteen to an engraver, found time in his leisure to master English and the classics, to pass his baccalauréat and the difficult matriculation of the Polytechnic School.

His "Cosmogony of the Universe" attracted the attention of the great Leverrier, who admitted him to the Paris Observatory. Here he was attached to the Bureau des Calculs, and during the four years which he spent there he made certain observations of comets which have been described as the most interesting of the century.

His reputation was made, and at once, by the publication of "The Plurality of Inhabited Worlds." It was originally published by Mallet-Bachelier, printer to the Paris Observatory, and this edition—at two francs—was immediately exhausted. Flammarion, who in the meanwhile had been approached by Didier, the publisher, then prepared a second edition, making many additions to the text and rewriting many of the chapters.

"You see," said he, holding up copies of the first and second editions side by side, "that the second edition was about four times as large as the first."

"The Plurality of Inhabited Worlds" is now in its thirty-ninth edition, and has been translated into every modern language. As Flammarion admits, the subject was treated in the eighteenth century by Fontenelle. He claims, however, for his, that it is a scientific work, while Fontenelle's may be described as a novel, a piece of literature.

After the success of this work had been confirmed, Camille Flammarion mainly devoted himself to the production of popular literature. He joined the staff, at the age of twenty-two, of a scientific magazine called Cosmos, collaborating at the same time on Le Magasin Pittoresque and Le Siècle, then under the editorship of Henri Martin. At the same time he was working at the Bureau des Longitudes, and had fitted up a small private observatory in his house in the Rue Ligny-Lussac. At the age of twenty-three he was appointed lecturer at the Ecole Turgot, and in 1867 he joined the French Aërostatic Society, of which he afterward became president. His interesting volume "Voyages en Ballon" describes the twelve different ascents he made. Of these, the longest was one he took in 1880, when he traveled from Paris to Cologne; but the most interesting one was, no doubt, his aerial bridal tour, which was undertaken on August 28, 1874, with Madame Flammarion, eight days after his marriage. It lasted twenty-four hours, and ended at Spa.

"What more natural," he said to me, "than for an astronomer and his wife to fly away thus like birds?"

As an aërostat, Flammarion rendered services to science.

"During my balloon voyages," he told me, "my time was chiefly spent in meteorological observations. I first verified the fact that the rapidity of the horizontal motion of the air increases enormously with the altitude reached, and also that as many as five different atmospheric layers, one above the other, can move in opposite directions and at varying rates of speed. You will grasp the importance of this discovery as a method of guiding the direction of balloons. I was also the first to observe, describe and explain the optical phenomenon of the colored aureola which surrounds the shadow of a balloon which is cast upon the clouds beneath."

"As an astronomer," he added, "I have devoted special attention to Mars, because it is the planet about which one has most reason to hope that definite information may be obtained."

The special interest which he takes in Mars is curiously revealed to the visitor to his house by a part of his dining room furniture. In this room, the walls of which are decorated with astronomical maps, there is, at the side of the tiled stove, a bookcase which is filled with cases fashioned to represent large volumes. Each case is used for the classification of the papers which the savant receives from all parts of the world, referring to various branches of astronomical study. Thus Mars has its separate case, and Jupiter also, the other planets being disposed of in one single case, labeled "Planets other than Mars and Jupiter." The dining room chairs, by the way, are decorated with the signs of the zodiac, while a picture of Urania smiles down from a painted plate above the buffet.

Of his "Catalogue of Double Stars," perhaps his most valuable contribution to astronomical science, he spoke as follows on the occasion of our conversation:

"From 1873 to 1878," he said, "my attention was almost entirely absorbed in the study of double stars. Up to 1873, although numerous observations had been made on these remote stellar systems, these observations had not been classified. In my opinion the double stars constitute one of the most important aspects of sidereal astronomy. Yet at the time that I approached the subject, that is to say, during 1873, I discovered to my surprise that there was a total absence of documents concerning it. A number of questions, which so far had been unanswered, presented themselves to my mind. How many double or multiple stars are known? What is their proportion to the number of single stars? In the total number of groups which have been discovered, how many are simply optical phenomena due only to the effect of perspective, and how many are genuine or physical systems? Which are the couples of which we can verify the orbital movement? Which are those of which the orbital movement is probable? Are there any of which the movement is not orbital? By what intrinsic movements are these systems transported into space? These are some of the questions which presented themselves to my mind, and which it seemed to me must present themselves to the mind of every student who approached the subject. The only way to solve them was to examine in a detailed manner each one of the eleven thousand double stars which up till then had been discovered, to compare my observations with those previously made, amounting in all to upward of two hundred thousand, to deduce the conclusion furnished by this examination for each group, to form another list of the couples whose constituents have remained fixed; to form another list of the stars whose movements could be verified as invariable, to identify these stars, to examine the intrinsic movements of each set, to analyze the variations which I had observed, to establish definitely which were the physical systems endowed with an orbital movement, and which were the groups which could be described as the result of a mere optical delusion. This is what I did. I spent more than a whole year over the work, being greatly assisted by the kindness of Leverrier, who, much interested in my researches, placed at my disposal the great equatorial in the east tower of the Paris Observatory."

The result of all this labor, the "Catalogue of Double Stars," was published in 1877, and in the same year Flammarion published his "The Lands of the Sky." In 1879 he began the publication of his "Popular Astronomy"—one of the most successful of his works, from which he has already drawn considerably over £5,000 in royalties. To this a supplement appeared in 1881 entitled "The Stars and Wonders of Heavens."

"In 1886," he told me, "I wrote my book, 'The World Before the Creation of Man.' This was a subject about which I had always wished to write. Indeed, when I was but a lad of fifteen, at the Jesuit Seminary in Paris, I had begun a book on that theme."

It is, perhaps, by his novel "Urania" that Camille Flammarion is best known among the large circle of readers who take no interest in astronomy as a science and are not ashamed to admit the fact.

It was, by the way, a clock which gave Flammarion the idea of writing this novel. This clock is still to be seen in the drawing room of the astronomer's apartment in the Rue Cassini. It represents the figure Urania, and is a magnificent piece of workmanship. The maker, a once famous clock maker, constructed three, and three only, of this model. One of these clocks ticked for Napoleon III, and now ticks for Monsieur Felix Faure in the palace at Fontainebleau. The second has been lost sight of; the third, in M. Flammarion's salon, prompted him to write a successful, income-producing novel. A Cicero suggested to him one of the most striking incidents in this book, the story of the vision of the youths of Megara. "Urania" has been very successful, but as a novelist, at least, Flammarion is and will remain homo unius libri.

"I shall write no more novels," he told me. "If I wrote that one, it was because my desire and ambition are to impart scientific knowledge by every means in my power. The novel is in some sort a medium."

As Flammarion said these words I wished that Zola might have been there to hear. How he would have caught up this contemptuous qualification of the novel—"a medium in some sort"—he, who holds that the novel is, nowadays, par excellence the medium for the expression of thought in every branch of human knowledge.

To return to Flammarion.

"Personally, I hate novels," he added, "and never read any."

I asked him as to his literary labors in the future, and he said: "My time will be almost entirely taken up for some time to come with the 'Astronomical Encyclopædia,' which is to be a popular handbook to all the branches of the science. It will not be completed before 1902 or 1903. What leisure I have will no doubt be devoted to writing newspaper articles, but of these I shall write as few as possible, and only when something of very great interest occurs."

M. Flammarion's articles usually appear in English and French simultaneously, his services as a contributor being retained at an enormous fee by Gordon Bennett for the Paris edition of The New York Herald.

As an astronomer, he describes his present bent as follows: "I continue to study Mars as much as possible. I want to try and find out what is going on there. Mars interests me above all other planets, because it is the planet which most closely resembles the earth."

Trained as he has been by lifelong commerce with the most exact of all sciences, Flammarion—such are the infinite surprises of human psychology—has a marked tendency to superstition and a penchant for the supernatural. He affords an example of the fact that men who have strong capacities for good might also be pre-eminent in what is bad had not natural uprightness guided them in the better way. We might have had instead of Flammarion the astronomer, Flammarion the astrologer, or whatever is its modern equivalent.

As to his superstition, he has an instinctive horror of dogs—just like Alphonse Daudet, although, unlike Daudet, he is very fond of them.

"Whenever our Newfoundland down at Juvisy, Sirius, jumps up on my husband," said Madame Flammarion, "he turns pale."

"I have always thought," remarked the astronomer, "that in some previous existence I must have been bitten by a mad dog. This would explain this instinctive horror."

In his book "Lumen" he has expressed himself fully on the subject of occult sciences.

"I have always been intensely interested in the occult sciences," he said, "and have studied them for over twenty-five years from the writings of Alan Kardec down to Rochas and Papus. The last is a frequent visitor to my house, and has given numerous séances here. My conclusion is that there exist certain natural forces of which humanity is ignorant."

A favorite book of his, always to hand in the crowded study in the Rue Cassini, is P. P. Gener's "Death and the Devil"—a significant fact where the library consists of over ten thousand volumes.—R. H. Sherard, in The Humanitarian.

PREDETERMINING SEX.

THE world, scientific and domestic, is a good deal excited over the boy and girl question, and waiting with intense interest the formula of Dr. Schenck, the great Vienna scientist, how the thing can be done. It seems the question is really solved, but the distinguished scientist hesitates about putting the public in full possession of the facts, but lets them into the secret so far as to assure them that he himself is the father of six boys, all in a row, and that a distinguished archduke of Austria, who had been trying as only an archduke can try for nineteen years to become the father of a boy, awoke one morning bright and early to find—with the help of the great scientist, whose instruction the archduchess had carefully followed—the boy had arrived. We are not yet in possession of how the thing was done, but we are led to believe that carefully selected nutrition was a most important factor.

Is it possible Dr. Schenck has found out the secret by which the queen bee controls the sex of the offspring? When she wishes to develop a male brood, she lays unfertilized eggs. The eggs of a virgin queen and also of workers—which sometimes mysteriously possess the power of egg laying—always develop into males, or drones, as they are called. The fertile queen simply refrains from fertilizing an egg when she wishes to produce a drone.

This new idea of Dr. Schenck may not be more tenable than one which was launched upon the world during the second French empire, a[illegible] the following out of which, it is said, gave to F[illegible] the Prince Imperial. A large stock grower in S[illegible]witzerland noticed that cows who went to the bull early in the heat were seen to have heifers, while those who went to the bull late in the heat had bull calves. To test the matter he selected twenty cows and sent them to the bull in the first stage of the heat and the result was twenty heifers. He also selected two cows and sent them to the bull near the termination of the heat and two bull calves was the result. From these facts he formulated the theory that a male could only come from a fully ripened ovum, say after the fifth or sixth day from the termination of the menses, while previous to that time and for two or three days before the menses the result would be a female. In many years' observation we have noticed, while there were very many exceptions to this rule, still it seemed that a correct solution of the

mystery was somewhere along this line. Male and female children being born at the same birth would upset either theory as a whole, unless it could show that each conception was at a different date. The whole question seems to be but of slight importance, and if solved might be productive of more harm than good.—The Medical Times.

PHOTO-CERAMICS IN THREE COLORS: AN INDUSTRIAL PROCESS.*

THE chromo-photographic process in three colors has not yet been applied to ceramics, although, as a means of obtaining, at little cost, burnt-in reproductions of colored subjects, it has incontestable advantages. Of course, these reproductions can be done by the superposition of three transfers—one yellow, the other red and the third blue, printed from photo engraved plates. The manner of operating suggests itself, being entirely similar to that employed in manufactures, and not presenting other difficulties than the exact registering of the three colored monochromes, printed as usual on pellicles, or on a special tissue paper, each monochrome being burnt in before another one is placed over it. Besides this process, there is one in true half tones—i. e., without dots or lines—and therefore more artistic, which, we believe, has not been applied to chromo-ceramics, and which the industry can adopt with profit for certain kinds of work. We refer to the dusting process, adapted to the three-color method. The object of this article is to describe it with sufficient detail to enable anyone to utilize it. The dusting process is based, as most of the readers of photographic publications probably know, on the hygroscopic property of certain substances—glucose, sugar, gum arabic, dextrine, etc.—which, when acted on by light in presence of an alkaline bichromate, gradually lose their hygroscopicity, whereby any matter, ground into a very fine powder, and dusted on a layer of the bichromated substances in question, previously impressed by light under a cliché, adheres upon it in being distributed in gradation from light to shade, according as the luminous action has more or less, or not at all, modified the hygroscopicity of the substance. The result is a perfect countertype of the cliché, whether negative or positive.

The following compound is trustworthy. It keeps well in the dark for a week or ten days in good condition. It is advisable, however, to employ it within forty-eight hours after its preparation. Before use, it should be filtered with care: Glucose, liquid, 50 m.; gum arabic (powdered, the best), 25 gr.; ammonium bichromate sat. sol., 2 dr.; water, 1 oz.

The material (glass, porcelain, faience) is flowed with this compound, drained in a vertical position for a few seconds, and the excess of liquid accumulated at the lower edge being wiped off with a rag, the coating is rapidly dried over an alcohol lamp, or in an oven heated sufficiently to avoid crystallization. Three or four minutes should suffice to completely desiccate it.

Small plates can be coated in this way. If they are large, it is well to equalize the coating by means of the turning table at a slow speed. Such a table, with a gas ring under the whirler, as is employed in some photogravure establishments, is quite handy, for the coating dries at the same time that it is equalized. The temperature of the plate should not exceed 110° Fah., and the operation must be done by a yellowish light.

While coating, it sometimes happens that the bichromated compound does not flow well on the material, it divides and contracts, leaving bare spaces. One avoids it by rubbing the plate with alcohol and rottenstone or whiting, rinsing well under the tap, and, after draining, coating the plate while it is surface-wet. This done, the excess of liquid is drained and thrown away, when the plate is coated again, but in another direction. Bubbles of air and dust must be avoided with the greatest care. They give rise to stains, which it is very difficult to retouch.

In the process now in question only diapositives are employed for printing, and it very often happens that the material upon which the colored image must be printed and burnt in is not exactly plane, and therefore does not admit the use of rigid clichés. They should be made first on patent glass plates, then transferred on flexible and translucid pellicles. Another reason for having the diapositives on such pellicles is that they can be used as reversed clichés to obtain the image in its true way.

When the image is to be vignetted—portraits, for example—as it cannot be very well done in printing on bichromated films, and as the picture is an exact reproduction of the diapositive, the latter should, consequently, be vignetted when printed from the negative. The negatives must be of medium intensity, perfect, clear, free from fog. For that purpose it is advisable to somewhat overexpose in order to obtain the faintest details in the shadows without pushing the development to force them out, and, as a consequence, to obtain the half lights and shades with their relative values. A slow development is recommended. Intensification—we always speak of picture in true half tones—is objectionable, since, by increasing the intensity (and therefore the contrasts), it often impairs the transparency of the half tints, and blocks off the delicate details in the deep shadows. The diapositives should be clear, transparent, possessing, in a word, the characteristic of the negatives. Their intensity should be about that of lantern slide—rather less, if anything. They are best made by the collodion process, or Carbutt's gelatine plates for transparencies.

The negatives are made, of course, by the three-color process, whose description we cannot give in this article with sufficient detail to be useful, on account of its length. We will, however, say a word (theoretical) about the screens employed to make the analysis of the three primary colors, as it is the most important part of the process.

Examined by the spectroscope, the screen for the blue printing negative should absorb the colored bands from H to E ⅔ D—that is, from the extreme violet to the line of the yellow. The ultra-violet rays should be suppressed. The color of the screen is orange. It must tend more to red than to yellow. The screen for the red printing negative should absorb the colored bands from A to C ⅓ D—that is, the red and orange. The color of the screen is green-yellow. It must tend more to green than to yellow. The screen for the yellow printing negative should absorb the colored bands from E to D ⅓ C—that is, the yellow and green. The color of the screen is blue-violet. It should tend more to blue than to violet. The bands absorbed by the screens should be well defined. However, as the color of the same—the orange-red especially—necessitates much lengthening of the exposure time, it should not be deeper than useful to effectively restrain the action of the rays, which should not act on the photographic film.

As to the photographic plates, one may use for the three negatives those sensitive to red and yellow. It is advisable to color sensitize one's self the gelatino-bromide plates of ordinary sensitiveness prepared without iodide. Better and more certain results are obtained. To avoid a cause of frequent error, each negative, and, in consequence, each diapositive, should be labeled with the name of the color to be employed when printing from it, and, for registering, marked with three transparent dots on the negative, in order to superpose the images, so as one exactly coincides on that previously printed.

EXPOSURE.

The material, coated with the bichromated compound, is exposed under the diapositive when dry, and, to prevent it from absorbing moisture during this operation, while still warm.

The exposure time necessarily depends upon the intensity of the cliché and the state of the weather. If the cliché is, as has been advised, of medium intensity, clear in the shadows, and the sky not overcast, from three to five minutes' exposure suffices in the shade. Exposing in the sun is not advisable, and should be absolutely discarded with pellicle diapositives.

When the exposure has been short, the picture is very soft and the contrasts deficient. On the other hand, they are more or less exaggerated by overexposure. As much as possible the exposure time should be exact, for in the three-color process each proof should have very nearly the same character; else, when the synthesis is complete, one will obtain a coloration different from that of the original.

DEVELOPMENT.

The development can be done by diffused daylight. It is a very simple operation. On its removal from the printing frame, the plate is placed on a large white cardboard, or, better, in a very shallow box (about 2 inches deep) made with this material, and the film allowed to absorb moisture for, say, two minutes; then a certain quantity of the vitrifiable color ground into an impalpable powder—this is important—is thrown upon it by means of a pepper box. This done, one gently rubs it all over the plate for a moment, describing small circles, afterward allowing the film to absorb more moisture before renewing the operation.

On the first application of the powder only the deep shadows and the half shades appear. It should be so. Should the impression take hold of the powder rapidly in the half lights and delicate details, it would indicate underexposure, and the image would become spoiled. In such a case it is better not to proceed, but to wash out the preparation in order to perform the operation over again. On the other hand, if the details hang back, or if, after, say, ten minutes, the development does not progress any more, or, also, if the contrasts of the picture are exaggerated, the plate has then been overexposed, and no good result can be expected, even by breathing upon the film to impart moisture, and thus to force the development. However, local breathing by means of a tube is sometimes advantageous to bring out the details in the lights without intensifying the shadows when the exposure time has been a little too much prolonged. On the whole, it is better not to resort to any dodge for improving the impression. The result is never an exact countertype of the cliché which it is so important to secure in the three-color process. There is, of course, a certain latitude, but not as great as for plain monochromes. When all the details are well developed, the plate is heated to remove the moisture it has absorbed, and the superfluous powder dusted off carefully, in order not to remove it from the delicate half tints, where it does not adhere, as well as in the other parts of the image. Now, it remains to eliminate the bichromate not acted on by light—that is, to fix the image, as it is termed. For this purpose, one prepares the following bath: Fused borax, powdered, 125 gr.; alcohol, 12 oz.; water, 4 oz.

The borax is first dissolved in the water by the aid of heat, the alcohol added, and the solution filtered when cold. The plate is immersed in a certain quantity of this solution until the yellow color of the film has disappeared, then removed into another (new) quantity of the same, in order to secure a complete elimination of the bichromate. The plate is allowed to dry afterward.

As to the vitrifiable colors, they should be translucid. They are found in commerce, but very often not powdered sufficiently fine for our purpose. We specially recommend the color of Lacroix. In selecting the color—yellow, red, carmine, blue—one should observe that they should be appropriate to the material upon which they will be burnt in. Those prepared for porcelain and faience painting are too tender for enamel plates on account of their great fusibility, while the same would be too hard—not sufficiently fusible—to be employed on glass. Hence, one should be careful to select them according to the material to be decorated.

As we have said before, the burnt in chromo-photographics are done either on plate and window glasses, porcelains, tiles, etc. On glass plates, and on any other material with a nearly plane surface, the work is easy, but on curved surfaces it offers some difficulties, on account of the registering of the transfer proofs, which should be on pellicles often somewhat extending or contracting, and therefore not preserving their original form, which therefore prevent the three images from coinciding exactly.

On plane surfaces the process is direct—that is, the three monochromes are successively made and burnt in on the material itself, without having recourse to transfers. Thus, one commences to print, develop, etc., the yellow proof, and, after firing, the material is again coated when cold with the bichromated compound, then exposed under the red printing diapositive, developed with the red vitrifiable color, fired, and the synthesis completed by superposing the blue print in operating in the same way. As by firing no change occurs in the dimensions of the pictures, the registering offers no difficulty whatever, provided the registering opaque dots coincide in the three diapositives. Of course, each color can be done by series, preparing, for instance, all the yellow proofs to fire them together, then proceeding with the red, firing, and lastly, printing the blue proofs. The reader understands that, since all the colors are transparent, the order of superposition, yellow, red, blue, can be done in any other way, specially for transparencies.

The third proofs being burnt in, the result is an encaustic facsimile of the model, with its colors very approximately reproduced. However, sometimes it is well to complete it by a fourth monochrome in bistre, or a neutral tint made by mixing the three colors, red yellow, blue, in certain proportion, or any other appropriate tint, from a special cliché, or applied by hand, when making the retouches which may be necessary, in order to give relief to the whole picture, and, by forming a general shading, to stump the crudeness of the colors.

The work on curved surfaces is done as follows: The yellow proof is first made on a glass plate quite clean, and, after development, covered, in avoiding striæ, with plain collodion at 1¼ per cent. When the film has set, its edges are cut all round with the point of a steel scraper—not by dragging, which would cause the film to wrinkle, but by vertical strokes. This done, the plate is immersed for a few minutes in water slightly acidified with nitric or sulphuric acid (two or three per cent.), where the chromic compound is eliminated, and the collodion film becomes loosened. After rapidly rinsing, the plate is placed in a vessel with a five per cent. solution of dextrine, in which the film, with the image adhering to it, soon detaches itself, or may be easily detached by lifting it with the point of a brush. It now remains to transfer it on to the material, collodion side in contact with it.

When the object to be decorated is large and hollow—a plate, for example—it serves to hold the dextrine solution, and, as soon as the pellicle is detached, the liquid is slowly drained off, and the pellicle placed on the plate in the proper position. When dry it is fired, and one proceeds in the same way for superposing the two other monochromes.

If the object is small, concave or convex, it is introduced in the dextrine solution, poured in a large vessel, as described above, and placed under the pellicle, and holding the latter in contact with the object, both are lifted out from the liquid in an inclined position, when one proceeds as above explained.

But, should the object be large and convex, then one operates as follows: A sheet of transparent paper is introduced in the dextrine solution, under the pellicle, and, both in contact with each other, removed from the solution. The paper is now cut so as to be of the same size and shape as the proof, and the latter immediately transferred on the material while wet—the manner of doing it is obvious—then sponged by covering it with a sheet of tissue paper and blowing over the whole. This is repeated two or three times. Now, again covering the proofs with tissue paper, one gently dabs over it, as it dries before a stove, with a plug of wadding, in order that it may fit the curvature of the object.

As is seen, the transferring to very convex surfaces, often not developable, is not by any means as simple and facile as on other surfaces. For monochromes to be colored or not, the difficulty is easily mastered by an experienced hand; but to exactly register proofs one over another, as it should be done in the chromo-ceramic process just described, is quite different. On the whole, this manner is not industrial, and the manufacturers should, in the case now in question, have recourse to printed transfers from photo-engraved plates similar to those employed for the three-color illustrations of magazines.

* By P. C. Duchochois, in Anthony's Bulletin.

SILVER GLAZE AND THE VARYING COLORATION IT PRODUCES IN DIFFERENT GLASSES.

IN Dingler's Polytechnisches Journal, R. Zsigmondy describes a new method for coloring glass yellow by means of silver salts, and also deals with the reactions occurring in the development of the color.

The new method consists in applying a mixture of silver oxide, or a silver salt, with a flux of fusible phosphates, to the surface of the glass, which has previously been heated, whereupon as the glass cools the coating of flux springs off, leaving the surface stained a more or less intense yellow. The preparation of the flux is a simple matter, and consists in fusing together nitrate of silver and fusible phosphates, the proportions generally employed by the author being: sodium metaphosphate, 20 to 30 parts; silver nitrate, 4 parts. Owing, however, to the difficulties in the way of rapid cooling—an essential condition of the operation—the process is inapplicable to large articles, though small objects, prepared before the blowpipe, can be colored in a very short space of time.

An endeavor was made by the author to solve the disputed question whether the cause of the coloration of glass by silver is effected by the latter in the metallic state direct or as oxide or silicate; as also to ascertain what constituents of the glass assist in the development of the color.

As regards the first part of the question, an experiment performed by heating a silver lined tube in a current of hydrogen, and afterward in a current of oxygen, demonstrated that, in the metallic state, silver is incapable of being absorbed by glass, though when oxidized it is taken up readily. The formation of the characteristic color did not, however, ensue until the tube had been subsequently heated again in a current of hydrogen, thus implying that the absorbed oxide must first suffer reduction to the metallic state before becoming chromogenic.

Pure glass, i. e., glass free from reducing agents, is found to be incapable of coloration by silver, the author having conducted a number of experiments with the phosphate and silver flux on various kinds of glass in a muffle furnace, the glass plates employed being heated until they just began to bend, and the flux poured over the surface and left in the muffle for a short time, with the result that normal glass of known composition, together with pure water glass and mirror glass, were found to be either totally un-

affected as regards color or merely slightly tinged with yellow as a result of the accidental incursion of impurities during the melting of the glass mass.

On the other hand, when reducing agents, such as ferrous oxide, metallic lead in solution in the glass, and other reducing agents were present, the yellow coloration developed infallibly. In the case of iron oxides, the presence of as much as 2·4 per cent. of ferric oxide did not favor the production of color, whereas 0·96 per cent. of ferrous oxide sufficed to develop an intense yellow brown.

The author is also of opinion that while the essential constituents of glass have no affinity for silver, and can be varied in their proportions without producing any increase in susceptibility to the coloring action of silver, accidental constituents—in addition to those already mentioned—such as carbon, silica, metallic sulphides, stannous oxide, arsenious salts, etc., exert a reducing action on the silver oxide dissolved in the glass, and thereby favor the production of the color in question.

The same results as with the phosphate flux were also obtained by the mixture of clay and silver oxide ordinarily employed on a manufacturing scale.—The Pottery Gazette.

A CONTINUOUS STEAM ENGINE INDICATOR.*

By THOMAS GRAY, Terre Haute, Ind., Member of the American Society of Mechanical Engineers.

THE most important feature of this kind of indicator is the mechanism for producing continous forward motion of the record sheet by means of the backward and forward motion of the piston of the engine. A continuous uniform motion is, of course, readily obtained, either from one of the revolving shafts of the engine or from an independent source, and for some purposes is sufficient; but where the card is to be used for anything more than illustrative purposes, and even for that, it is desirable that the rate of motion of the paper should, at all parts of the stroke, bear a constant ratio to that of the piston.

A sketch of one form of the instrument which has been found to give satisfactory results is shown in Fig. 2. On the left of the sketch the cylinder of an ordinary indicator with its recording levers will be recognized. The recording pen is shown in contact with a ribbon of paper, F, near its lower edge. This ribbon of paper is drawn from a drum, G (Fig. 3), carried around an idler cylinder at I and wound on a drum, H. The rate of motion of the paper is controlled by the cylinder, C, which is driven by the engine in the following manner:

The wheel, A, is made to oscillate backward and forward through the required arc by means of any of the ordinary reducing-motion arrangements used for taking indicator cards. Cords or metal straps are attached to the upper and lower sides of the wheel, A, and carried in similar directions round the pulleys, B, B, which are fixed to the upper and lower ends of the shaft of the cylinder, C. The free ends of these cords are then led round the pulleys, D, and connected together through a short spring, E. If we now suppose the wheel, A, to be turned in such a direction as to pull the cord toward it round the upper pulley, B, the tension on the cord between the wheel and the upper pulley will be greater than the tension given by the spring, E, while the tension on the cord between the wheel and the lower pulley will be less than that given by the spring, E. The cylinder, C, will, in consequence, be given a clockwise rotation, the lower cord slipping round its pulley and acting the part of a strap brake to prevent excessive movement. When the motion of the wheel, A, is reversed, the cord between the lower pulley and the wheel has the greater tension, and thus causes the cylinder, C, to turn. This, however, also gives a clockwise motion to the cylinder, C, and hence it is clear that both the forward and backward stroke of the engine piston will turn the cylinder, C, in the same direction, and at a rate which, at every instant, is proportional to the rate of motion of the piston. The frame which carries the drums, G and H, swings round an axis at I, and is pressed toward the cylinder, C, by a spring. The paper ribbon passes between the drum, H, and the cylinder, C, and thus when the cylinder is turned the drum is caused to rotate and wind forward the paper. Since the drum, H, is driven, through the pressure of C, on the paper as it comes from the idler, I, and since C turns an equal amount for each stroke, the length of paper which passes the recording pen is also the same for each stroke, no matter how much paper may be stored on the drum.

The resultant turning moment given by the combined action of the upper and lower cords to the cylinder, C, may be expressed as follows:

Suppose the upper cord to be pulled, and let the tension of the side nearest the wheel, A, be T, while the tension given by spring, E, is T', and that on the lower cord between B and A is T", then we have

$$\frac{T}{T} = \frac{T'}{T''} = e^{\mu\vartheta},$$

where e is the base of the Naperian system of logarithms, μ the coefficient of friction between the cord and the pulley, and ϑ the angle of lap of the cord in radius. We thus get a forward moment of

$$M = (T - T')\,r = T\,r\,(e^{\mu\vartheta} - 1)$$

and a backward moment of

$$M = (T - T')\,r = T'\,r\,(e^{\mu\vartheta} - 1),$$

where r is the radius of either of the pulleys, B.

Taking the difference of these two moments, we get for the effective turning motive the expressions

$$M - M = (T + T' - 2\,T)\,r = (T - T')\,(e^{\mu\vartheta} - 1)\,r =$$
$$T''\,r\,(e^{\mu\vartheta} - 1)^2.$$

This turning moment is evidently always such as to turn the drum in the same direction, whether the upper or the lower side of the wheel, A, recedes from the cylinder, C. The pull, T', should always be sufficient to insure that the cord which has to slide should do so without becoming slack; that is to say, T' should be large enough to prevent any accidental sticking of the cord from causing T" to become zero.

When, under the circumstances just described, a curve is drawn on the ribbon by means of a pen, the height of which above a datum line, corresponding to zero pressure, is proportional to the steam or gas pressure on one side of the piston of the engine, the area of the paper included between the datum line and the curve is proportional to the work done on that side of the piston. This work is positive for the forward stroke and negative for the backward stroke. If the indicator piston and piston rod be properly proportioned to suit those of the engine tested, and the ends of the indicator cylinder be connected to the corresponding ends of the engine cylinders, the ordinates of the curve will at all times be proportional to the effective rate of working. For the study of the action of the working fluid, the effects of different setting of valves, of throttling, of varying speeds and so forth, the most convenient arrangement is to connect one end of the indicator cylinder to one end of the engine cylinder in the ordinary way. The atmospheric line is drawn by a second pen (not shown in the sketch), which is made to serve the double purpose of drawing a datum line for the diagram and of marking a time scale on the ribbon. The time scale is obtained by attaching the pen to the armature of a small electromagnet, the coil of which is in circuit with a battery and a break circuit clock. The clock used marks half seconds, and works satisfactorily even when carried on the front of a locomotive drawing an express train.

The paper ribbon on which the record is taken is usually about 2 inches broad, and is carried on a light brass drum, G (Fig. 3), which is prevented from turning too freely by a light friction brake. The paper is passed over the idler, I, for the purpose of presenting a writing surface in a constant position relatively to the pen levers and also for the purpose of allowing the drums, G and H, to be placed a short distance from the indicator cylinder. This precaution is advisable in order to prevent escaping steam from wetting the pulleys, B, or overheating the cylinder, C, which is found to work best when covered with rubber. The drums, G and H, are made interchangeable, and provision is made so that they can be quickly removed and interchanged so as to use the paper more than once if desired. A number of drums are provided, so that ample paper is available for a number of tests. Each drum carries upward of 200 feet of ribbon, and hence, allowing 2 inches to each stroke of the engine, one roll of paper is capable of taking over 1,000 successive strokes.

The method of feeding the paper ribbon adopted in this instrument requires the cylinder, C, and the drums to be carefully adjusted so as to prevent the paper from traveling toward one end or other of the drum, H. When the adjustment is once made, however, the apparatus works perfectly. A somewhat more perfect but much more expensive arrangement is to drive the storage drum by clockwork and a spring, while the paper is passed between the cylinder, C, and a second roller. The cylinder, C, then simply controls the motion, and is then somewhat more easily driven.

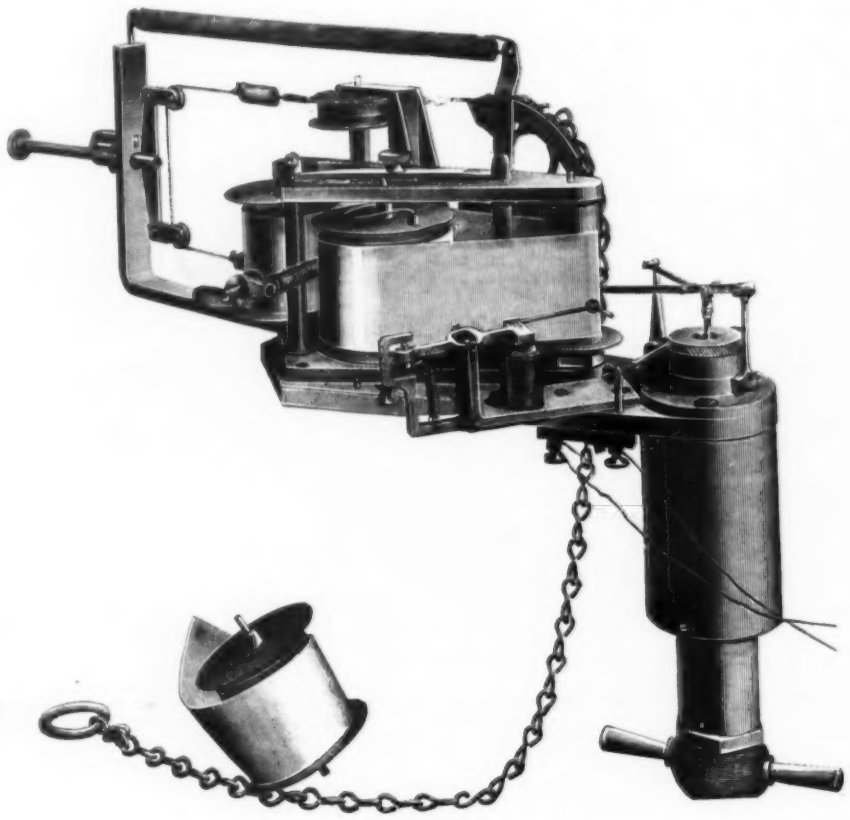


FIG. 1.

Fig. 2.

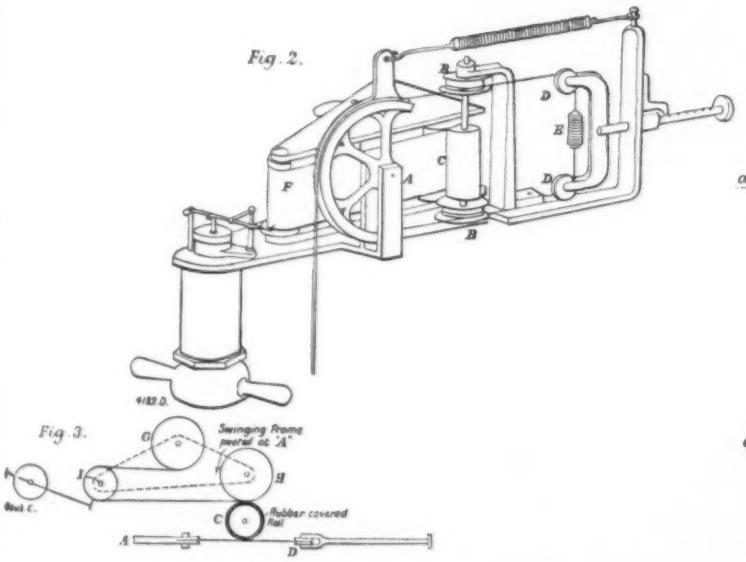


Fig. 4.

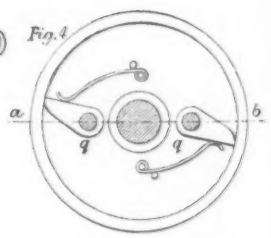
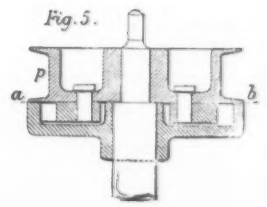


Fig. 3.

Fig. 5.



Both of these arrangements give cards of equal length, no matter how much paper is on the drum, H. When quantitative measurements from the cards are not required, the paper may be wound directly on to the cylinder, C. The cards then increase in length as the amount of paper on the cylinder increases, but this is unimportant in such a case, as the change for successive cards is not noticeable.

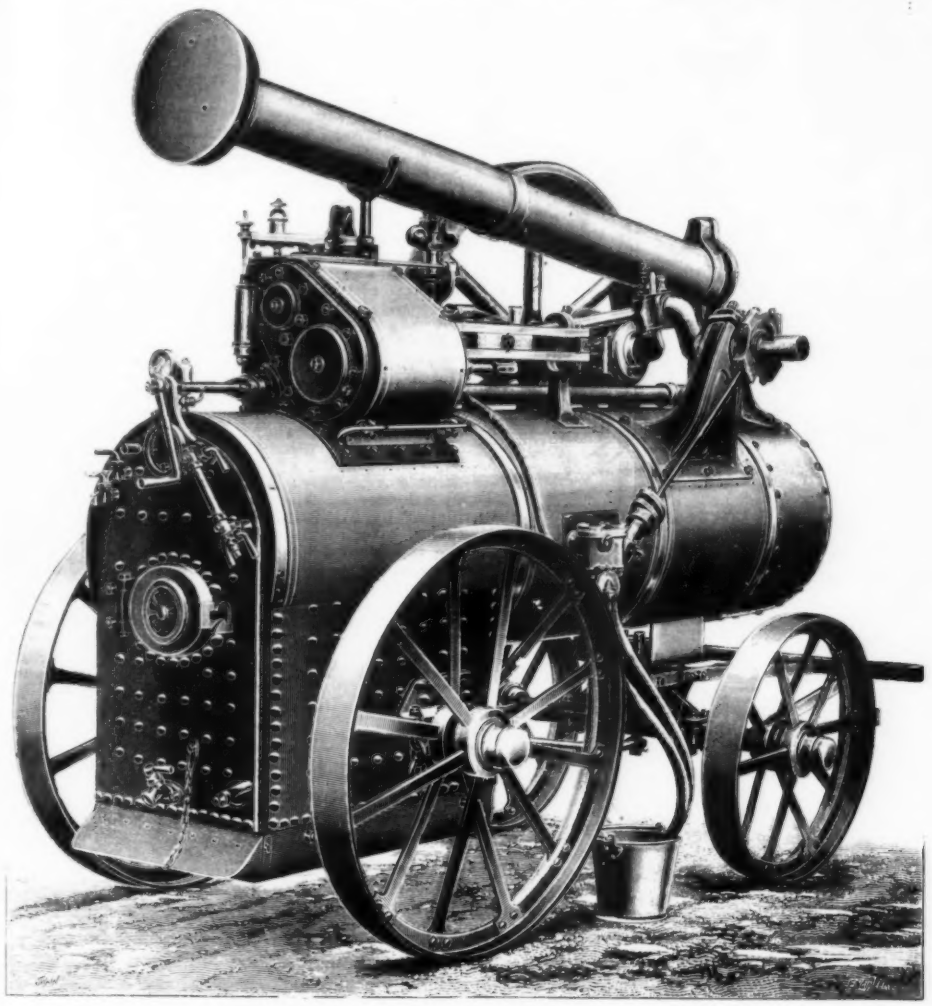
Another method of driving the cylinder, C, is indicated in Figs. 4 and 5. Fig. 4 is a plan of the part below a, b in Fig. 5, and Fig. 4 may be taken as a section on a, b (Fig. 4) of one end of the shaft and driving mechanism of the cylinder, C (Fig. 2). In Fig. 5 the driving pulley is shown at p. It is in this case loose on this shaft, but carries two pawls, q, q (Fig. 4). These pawls are pressed by springs against the rim of a shallow cylindrical box which is fixed to the shaft. The pawls are so adjusted that when the pulley turns in one direction (clockwise in the figures), the box, and therefore the cylinder, C, is turned with it; but when the pulley turns in the opposite direction the pawls simply slip round, while at the same time the cylinder is turned by the pulley on the other end of the shaft. In

* Presented at the Hartford meeting (May, 1887) of the American Society of Mechanical Engineers, and forming part of vol. xviii of the Transactions. The engravings are from London Engineering.

this arrangement the cords do not slip on the pulleys, but the connection of the pulley to the shaft is such as to slip in one direction and grip in the other. This gives precisely the same action as before, and has the advantage that for the same amount of driving power the frictional resistance is much smaller.

COMPOUND PORTABLE ENGINE.

WE illustrate below a compound portable engine built to a special order by Messrs. C. Burrell & Sons, St. Nicholas Works, Thetford. The general features of



COMPOUND PORTABLE ENGINE.

the engine are identical with those of their well-known compound road locomotive, the two piston rods laying hold of a single crosshead. This particular engine has been constructed without regard to expense, and is about as good as it is possible to make a portable engine.—The Engineer.

A BALDWIN PASSENGER LOCOMOTIVE FOR THE CHINESE IMPERIAL RAILWAYS.

THE Baldwin Locomotive Works, of Philadelphia, have recently sent eight locomotives to the Imperial Railways of North China, one of which is shown in the accompanying illustration. The engines are of two different classes, one being the regular "American" 8-wheeled class, as here illustrated, and the other is a "Mogul" engine, with six wheels coupled and a leading 4-wheeled truck, the former being intended for passenger and the latter for freight traffic. As far as possible the details of the two types have been made interchangeable among themselves. The boilers and their fittings, the cylinders, valves and valve motion, etc., are identical in both classes—a valuable feature in locomotives intended for foreign countries. The tenders also are of the same pattern.

The gage is 4 feet 8½ inches. The boiler shell is of homogeneous cast steel $\frac{5}{8}$ inch thick, the longitudinal seams being butt jointed with double covering strips, and the circumferential seams double riveted. The barrel is 60 inches in diameter at the smokebox end, and the designed working pressure is 180 pounds per square inch. Before delivery the boilers were tested under steam to a pressure of 200 pounds per square inch, and with hot water to 220 pounds per square inch.

As regards physical tests, the steel used in the shell has a tensile strength of between 55,000 pounds and 65,000 pounds per square inch and an elongation of 25 per cent. in 8 inches. It would, moreover, permit of a 1¼-inch hole being drifted out cold to 3 inches in diameter.

The firebox is 84½ inches long by 42 inches wide, and has a double riveted mud ring at the bottom. The fire door opening into the box is formed by flanging and riveting together the inner and outer sheets. A firebrick arch is fitted. Rocking grates and double dampers are supplied to both classes of engine. The tubes are 238 in number, 12 feet long and 2 inches in diameter. They are of charcoal iron and of No. 12 W.G., being specified to stand an internal pressure of 500 pounds per square inch. A section 1¼ inches long, cut from a tube, can be hammered flat without showing transverse cracks. For feeding the boiler there are two injectors of Sellers' 1897 pattern. The smokebox, it will be seen, is of the extension type, and is fitted with a spark arrester of the usual form.

The cylinders for each class of engine are of very hard close grained iron, each being cast in one piece with its half saddle and the right and left handed cylinders being interchangeable. They are 19 inches in diameter and the stroke is 2 feet. The driving wheels for the passenger engine are 84 inches in diameter over treads, and have cast steel centers 78 inches in diameter. The tires are of crucible steel and secured, as are those for the bogie wheels. The axles are of iron, being 8 inches in diameter at the bearings, which are 10 inches long and fitted with phosphor-bronze stops. Equalizing beams are fitted. The connecting and coupling rods are of I section, and are forged with solid ends. They are fitted with needle lubricators.

The cabs are of sheet steel painted, and have windows and doors. The safety valves are of the Ramsbottom pattern, and the pressure gage is of the Crosby thermostatic type. Westinghouse brake gear is supplied, the pump being 9½ inches in diameter, and is fixed on the left hand side of the engines. The cylinders are lagged with wood, and the covers are fitted with stamped sheet steel caps. The bodies are cased with painted iron, and the steam chest has a cast iron cap. The boiler is lagged with magnesia sectional lagging covered with painted sheet iron.

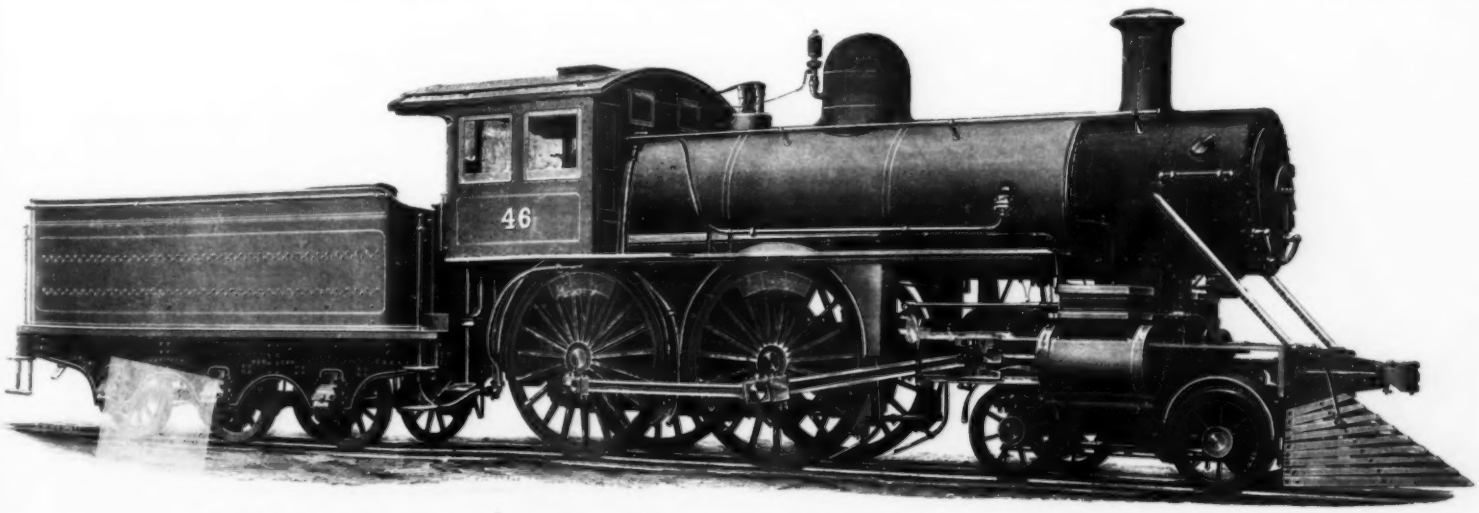
The principal particulars and dimensions of the engines are as follows:

	"American" Engine. Ft.	In.	"Mogul" Engine. Ft.	In.
Diameter of cylinders	1	7	1	7
Stroke of pistons	2	0	2	0
Wheels:				
Truck, diameter of	3	0¼	3	0¼
Coupled, diameter of	7	0	5	0
Total wheel base	23	2	23	3
Frames: Bar type made in two sections.				
Boiler:				
Diameter of smokebox end	5 ft.		5 ft.	
Thickness of plates	$\frac{5}{8}$ in.		$\frac{5}{8}$ in.	
Working pressure	180 lb. per sq. in.		180 lb. per sq. in.	
Firebox: Length	7 ft. 0⅛ in.			
Width	3 " 6 "			
Plate	½ in.		½ in.	
Grate area	24 sq. ft.		24 sq. ft.	
Tubes (charcoal iron) No.	238		238	
" diameter	2 in.		2 in.	
" thickness	No. 12. B.W.G.		No. 12. B.W.G.	
Heating surface in tubes	1,485 sq. ft.		1,485 sq. ft.	
" " " firebox	123 "		123 "	
Total	1,608 sq. ft.		1,608 sq. ft.	
Weight of engine in working order:				
On coupled wheels	71,000 lb.		107,000 lb.	
On bogie wheels	47,000 "		13,000 "	
Total	118,000 lb.		120,000 lb.	

Ten feet was fixed in the specification as the extreme limit of width for both engines and 15 feet for the limit of height. The tender, which, as already stated, is identical in pattern for both classes of engine, is of the 6-wheeled type, and is fitted with a U tank of ¼-inch plating inside and $\frac{5}{16}$-inch outside, holding 3,840 gallons. When loaded complete the tender weighs about 95,000 pounds, including 7 tons of fuel. The wheels are 3 feet 6¼ inches in diameter over treads, and have crucible steel tires 3 inches thick and 5½ inches wide. The axles are 6¼ inches in diameter at the journals, which are 10 inches long. There are equalizing beams between the middle and back axles. Both engines and tender are fitted with Janney couplers. Spring buffers are provided between engine and tender.—Engineering.

PROPOSED RAILROAD IN ABYSSINIA.

FOR some time there has been talk of a railroad being built from Djibouti, which is the principal seaport town of the French Somali protectorate in East Africa, to the city of Harar, in Abyssinia, and at last there is a reasonable assurance that it will be built, says United States Consul Masterson, of Aden. A company of capitalists, whose head office is at 5 Rue Scribe, Paris, are at the head of the enterprise, and their



EXPRESS PASSENGER ENGINE FOR CHINA, BUILT BY THE BALDWIN LOCOMOTIVE WORKS.

Cylinders, 19 in. by 24 in.; drivers, 7 ft. diameter; heating surface, 1,608 sq. ft.; weight of engine alone, 59 tons; steam pressure, 180 pounds.

secretary and general manager is C. Havard, of Djibouti.

As is well known, Abyssinia is one of the richest and most fertile countries on the continent of Africa, and Harar is its chief commercial city. The principal articles exported from that country are coffee, gums, hides, skins, civet, ivory, beeswax, and gold; while the two principal articles of import are cotton goods and petroleum. All the imports and exports going to and from this country to the seaport towns of Zaila, British Somali-land, and Djibouti, French Somali-land, are transported by camels in caravans. Considering the fact that Harar is about 280 miles inland, and these caravans only make on an average 10 miles a day, the carrying of goods is quite a costly as well as a slow process. It is only within the last few years that there has been much trade between the outside world and Abyssinia, and even now it is not possible to give correct figures of the total trade. Enough, however, is known to fully justify the building of this road.

The line has been surveyed between the two points, which are about 300 kilometers (186·4128 miles) apart, and work has actually commenced at Djibouti and several other points on the line. It is intended to build only a narrow-gage road at the start, the proposed gage between the rails being one meter (39·37 inches), and then, if the road proves a success, a broad gage can be easily substituted. All the laborers employed in building the road are Somalis and Arabs, as, on account of the heat of the low-lying coast country, the importation of white labor would be a useless expense.

A LATEEN ICE BOAT.

By H. PERCY ASHLEY.

POUGHKEEPSIE on the Hudson is the birthplace of ice yachting. In the year 1790, Mr. Oliver Booth, of that place, built a crude box and placed it on runners driven by a small square-headed spritsail. It was the crudest form of what is now the speediest craft in existence. Mr. Nathan B. Cook, of Red Bank, N. J., in 1853 mounted his ducking skiff on three rude runners shod with hoop iron. As years rolled by, gradual improvements were made until the present sloop, with single backbone and elliptical steering box and well-balanced sails, an easily handled ice yacht appears. One of the latest developments of this king of winter sports is the lateen ice boat. I have known several sloops which have been changed to this rig that have greatly increased their speed and added new laurels to those already won. The first consideration in building an ice yacht is the lumber and the sawing of same. If possible, select your tree standing and saw as shown in Illustration B, Section 11. No. 1 in this cut is the backbone and No. 2 the runner plank. Observe where the heart of the timber touches each plank. When the planks are sawn off the heart expands, and gives the whole plank a natural, bowlike curve. This curve gives the ice yacht breathing power; in other words, acts as a spring, and eases the boat when running at high speed over uneven ice. This upward curve is never lost, although when great strain is placed on the yacht by pressure of wind on the sail or uneven ice, the curve (upward from ice) is straightened, but as soon as this pressure is removed the planks return to their original upward curve. The woods to be used for the backbone and runner plank in their relative value for lightness and strength are basswood, butternut and pine. The runners and runner guides are of well seasoned white oak, spars of spruce. The shape of backbone or center timber by scale is clearly shown in Illustration A. There are given two kinds of steering boxes, Illustration A being the Orange Lake style and Illustration B is the Hudson River type (see Figs. 8, 9 and 10). The nicety of calculation and work in the make-up of an ice yacht is the runner shoes, which is practically the heart of the yacht.

THE ICE BOAT IN POSITION FOR STARTING.

In preparing the wood pattern for the soft iron casting of the runner, the cutting surface fore and aft of the runner shoe should be given a slight rocker curve. Say, for a shoe that measures 5 feet 3 inches, the downward curve should be 1/8 of an inch at center, but quickening at ends, especially forward. After the soft iron casting has been trued up with files, grind stone and oil stone, and the ice yacht is in commission, a half hour's sail will determine whether the fore and aft curve of the runner is correct. It may have to be increased or diminished. Take the runners off immediately and correct apparent defects. For, if they are allowed to remain on the ice, the runners will acquire "water polish;" namely, they will with contact with the ice get so hard that a grind stone or file will have little or no effect on them. The shoes are pierced with four bolts for the fore runners and three for the rudder shoe. The shape of the midsection of shoe is shown in Illustration C, Fig. 1. The cutting point is 45 degrees. The measurements of shoes and runners (Figs. 4 and 5) are: Fore runners, oak over all, 6 feet by 6 inches by 2 1/16 inches; rudder, 3 1/2 feet by 4 3/4 inches by 2 1/4 inches; the fore shoes are 5 feet 3 inches by 2 inches, and from oak to ice 2 1/4 inches; the rudder shoe (Figs. 2 and 3) is 2 feet 10 inches by 2 inches by 2 inches. The dimensions of the backbone or center timber are 26 1/2 feet by 9 inches by 6 inches, shape of which is shown in Illustration A. The runner plank is 18 feet by 14 inches by 6 inches at center and tapering to 2 1/4 inches at extreme ends (see Illustration B, Figs. 6 and 7). The cockpit in the plate or steering box, shown in Illustration A, is of the Orange Lake type, and is 10 feet by 4 feet. The Hudson River steering box (see Illustration B, Figs. 8, 9 and 10)

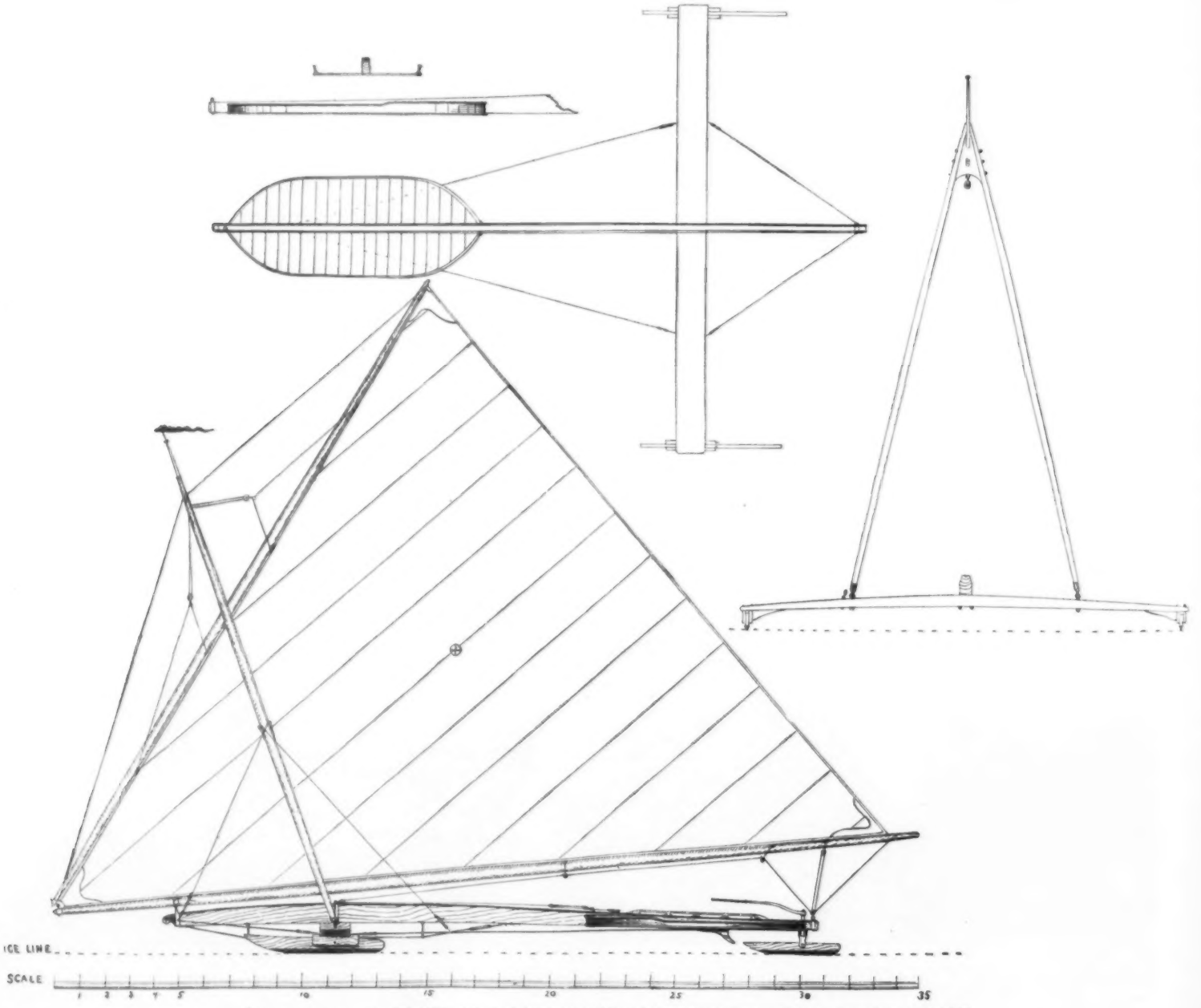


ILLUSTRATION A.—PLANS OF A LATEEN ICE BOAT DESIGNED BY H. PERCY ASHLEY.

is 8 feet by 3¼ feet. The former steering box has a flooring of ¾ inch pine and a bent oak combing 4 inches high by ½ inch thick. The latter (see Illustration B, Fig. 10) has a bent oak combing and bent flooring of light basswood, reinforced with oak at combing and center timber. The spars (see Illustration A) are of spruce and are of the following dimensions: each leg of wishbone that acts as a mast is 19 feet long and 4½ inches in diameter at center, tapering to 3¼ inches at ends, the lower ends having a straddle at runner plank of 9 feet, the upper ends meeting and being united with a fitted triangular piece of oak pierced with three bolts. At the lower extremities of wishbone (see Illustration A) are two interlocking eye bolts, the lower one passing through the runner plank ending in a nut, while the upper eye bolt is threaded with a liberal lag screw and pierces the lower extremity of backbone. Additional strength is given to this bolt by a cross section pin, which removes all chance for the bolt to turn or pull out. The boom is 33¼ feet by 5½ inches at the center, tapering to 4 inches at ends. An iron collar with ears is placed at the forward extremity. An eye bolt passes through the nose of the backbone and fastens to ears of collar, and is held in place by a bolt that pierces the ears at right angles. The yard is 29 feet 5¼ inches at the center, tapering to 4 inches at the ends. At the fore tip of the boom and yard is placed an iron collar pierced with an eye bolt to each. These two eye bolts interlock, thus forming a joint that will work at all angles required by the manipulation of the sail. The dimensions of the sail are: boom, 32 feet; yard, 27½ feet; leech, 28¾ feet. The center of sail effort is shown by small circle in the illustration. No. 10 ounce duck is used, the sail being crosscut, that is, the cleats are stretched at right angles with the leech. The usual afterguys and forestays of steel rigging ending in turnbuckles and running from runner plank to backbone are used. Half way up the wishbone pole are two guys of light steel rigging, the fore one ending at the nose of the backbone and the after one being fastened with lanyards to a point at the afterguys, as designated in the sail plan. These guys keep the wishbone in position when the sail is lowered. The sail is hoisted in place with a halyard and bridles on the yard. A pliable wire rigging whip is fastened to the upper end of yard, passing through upper wishbone and ending in a several part lanyard at the lower end of the spar. When the sail is lowered, the lanyard is cast off and the halyard performs its usual work. The advantage of this whip is, first, that it gives additional stiffness and holds the yard firmly in place and, second, that in case it is desired to bag the sail, the halyard only needs to be slacked away a little, but to make the sail set flat, the halyard is made taut until the proper tuning up of the sail is obtained. In other words, the two extreme ends of the yard remain stationary, and by tautening on halyard the yard has an upward curve, and by slackening this tackle the yard is given a downward curve by its own weight. The plans are drawn to a scale observed at the bottom of each illustration, which may be followed in carrying out the construction. The advantage of the triangular lateen sail is that the boat is not tilted by a good breeze, as the wind pressure bears mostly upon the lower part of the sail.

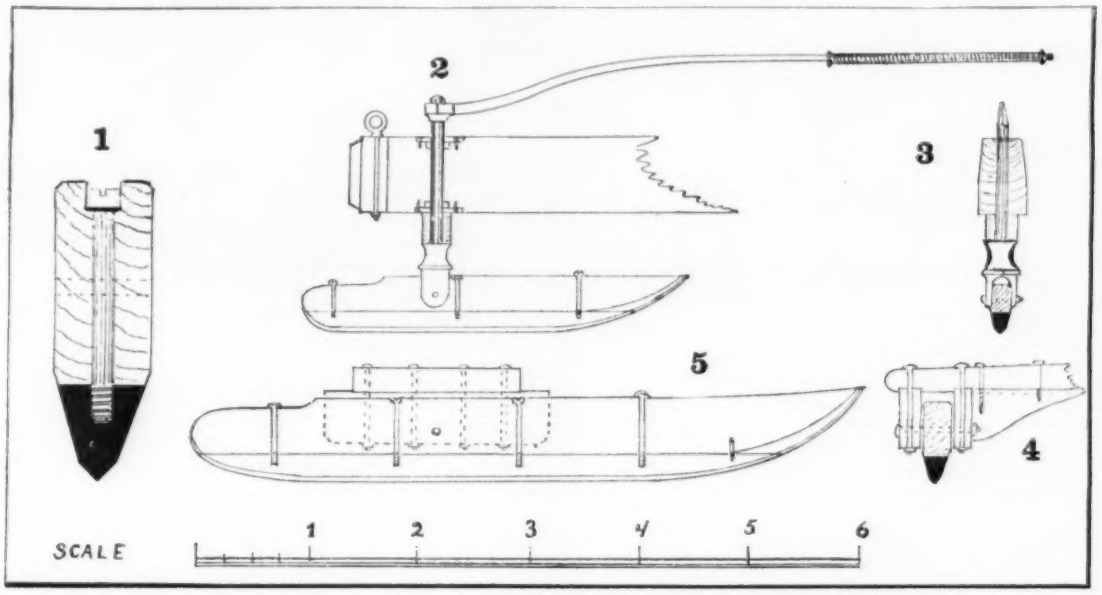


ILLUSTRATION C.—DETAILS OF THE RUDDER AND RUNNERS.

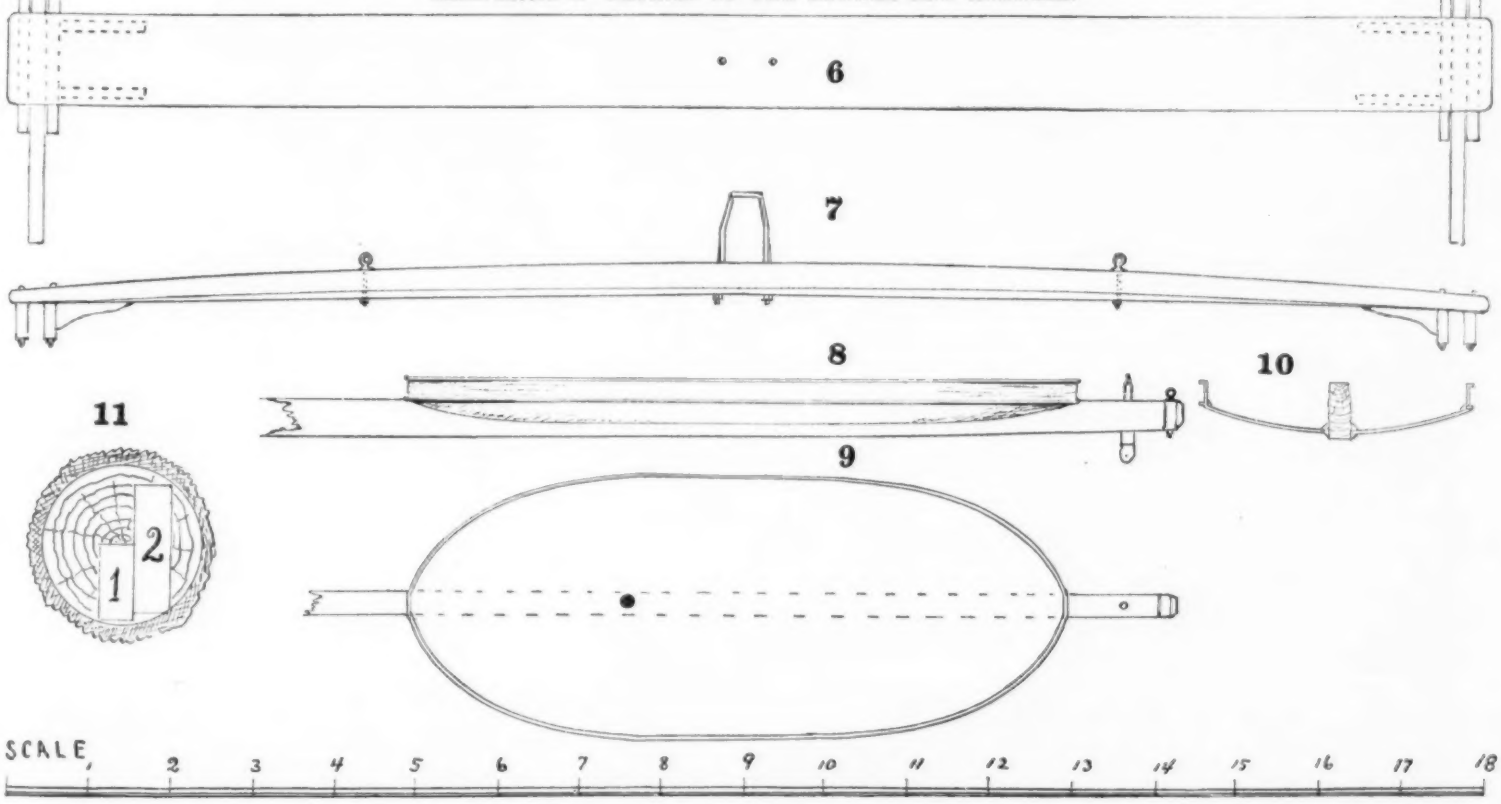


ILLUSTRATION B.—WORKING PLANS FOR THE CONSTRUCTION OF A LATEEN ICE BOAT DESIGNED BY H. PERCY ASHLEY.

COMMERCIAL VALUE OF SCALE INSECTS.

DR. L. O. HOWARD'S investigations into the commercial value of the scale insects developed some matters of general interest, says The New York Times. For many years the cochineal or cactus scale insect, now called Coccus cacti, was used as the basis of an important red dye, until practically superseded by the introduction of aniline dyes. In the same way the European Porphyrophora was used in the production of a purple dye. Aside from the dye insects, there are the lac insects, of which a single species, Tachardia lacca, produces practically all of the shell-lac, stick-lac, and button lac of commerce. This species is Asiatic in its distribution; but in the Southwestern States, upon the very abundant creosote bush, a lac insect occurs in an enormous quantity, the commercial possibilities of which have not been developed. This is the cogeneric species, Tachardia larreæ (Comstock). This insect has been known to science only since 1881, but was long prior to that time known to the Indians, who for many years have been in the habit of collecting the scale insects and forming them into more or less elastic balls, which their runners were in the habit of kicking before them as they journeyed from one point to another. There are other species of the same genus inhabiting North America. A third substance of commercial importance derived from scale insects is a pure white wax, which is secreted by the Chinese and Japanese Ericerus pe-la and by the Indian Ceroplastes ceriferus. On account of its expense, and on account of more or less available substitutes, this wax has not become of great commercial importance in Europe, but is much used in the eastern countries, both in the making of wax candles and in medicine. The Chinese wax is said to have ten times the illuminating power of other waxes. It is a beautiful wax, resembling beeswax in its chemical composition more nearly than the vegetable waxes, and is clear white in color. In the far Southwest there is a wax ixsect (Cerococcus quercus) which apparently needs careful investigation from the commercial point of view. Three species of oak offer food for this insect. Dr. Howard recently received specimens of the insect from Mesa Grande, Cal. They were not sent in position on the twigs, but had been removed from the twigs, and compressed together by hand into a more or less pliable lump, somewhat resembling a lump of India rubber, but not possessing the same elasticity. The substance makes an admirable chewing gum. Part of it has been proved by chemical analysis to be a true wax, and part resembles rubber in its physical properties. The project is not only interesting from a chemical standpoint, but it may prove to be also of economic value, as the supply is well nigh inexhaustible. By directing attention to these products of potential importance, Dr. Howard demonstrates the commercial uses of entomology.

IN THE ITALIAN MARBLE MOUNTAINS.

SERRAVEZZA.

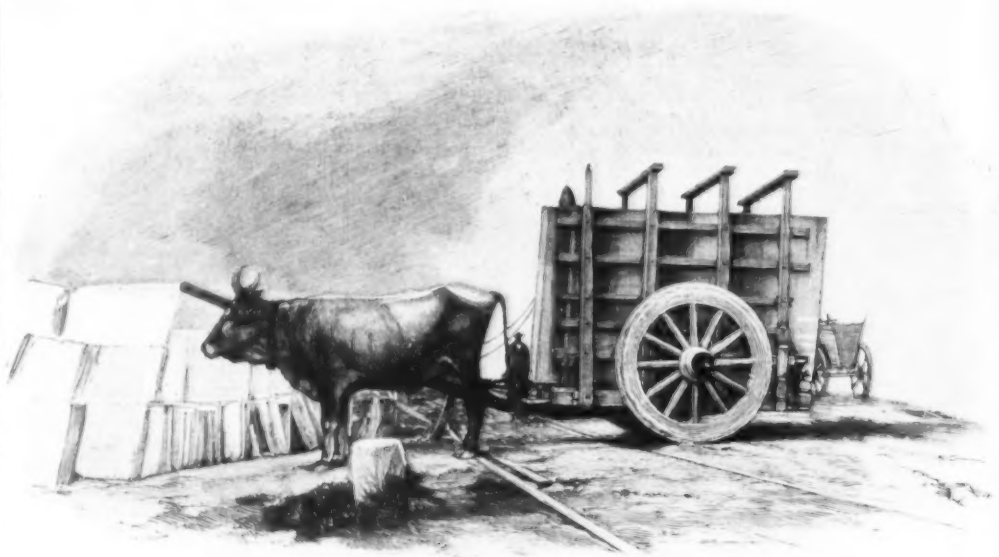
THE finest marble that can be bought is still spoken of as Carrara marble, although it is well known in the trade that the best quality of marble no longer comes from Carrara, but from Serravezza, from the quarries that were opened up by Michelangelo but could not be worked in his time for lack of means of transportation. Now they are in the hands of an energetic Swiss, Mr. Henraux, who is delivering to sculptors marble with a grain that cannot be equaled in the quarries of Carrara. Most of the marble in Mount Altissimo is his and his works supply the entire neighborhood with bread. But, after all, commerce has rendered art a poor service, for speculation has increased the price of this valuable material so as to put it beyond the reach of many.

The quarries of Serravezza are not as easily reached as those of Carrara, but a trip to them offers to the tourist all the charm of an expedition into the mountains. He is deceived at the station of Querceto by a sign bearing the name "Serravezza," which would seem to indicate that he has arrived at his destination, whereas, in reality, he has only begun his journey, for Serravezza is several miles from the station. Here is a grove of olive trees that lies like a light gray veil between the mountain and the sea through which the red marble of the Ceragiola quarries is distinctly visible. This is a good place to see the olive trees in their natural form. Near Florence they are cut back and down, but here they attain a great height and their weird, twisted trunks and proud crowns produce a fine effect. High orange trellises are placed against the houses, the bright, golden balls making a fine contrast with the green foliage. The place is quiet and peaceful, the deeply rutted white road and the trucks carrying marble being the only indications of the neighborhood of an industrial center.

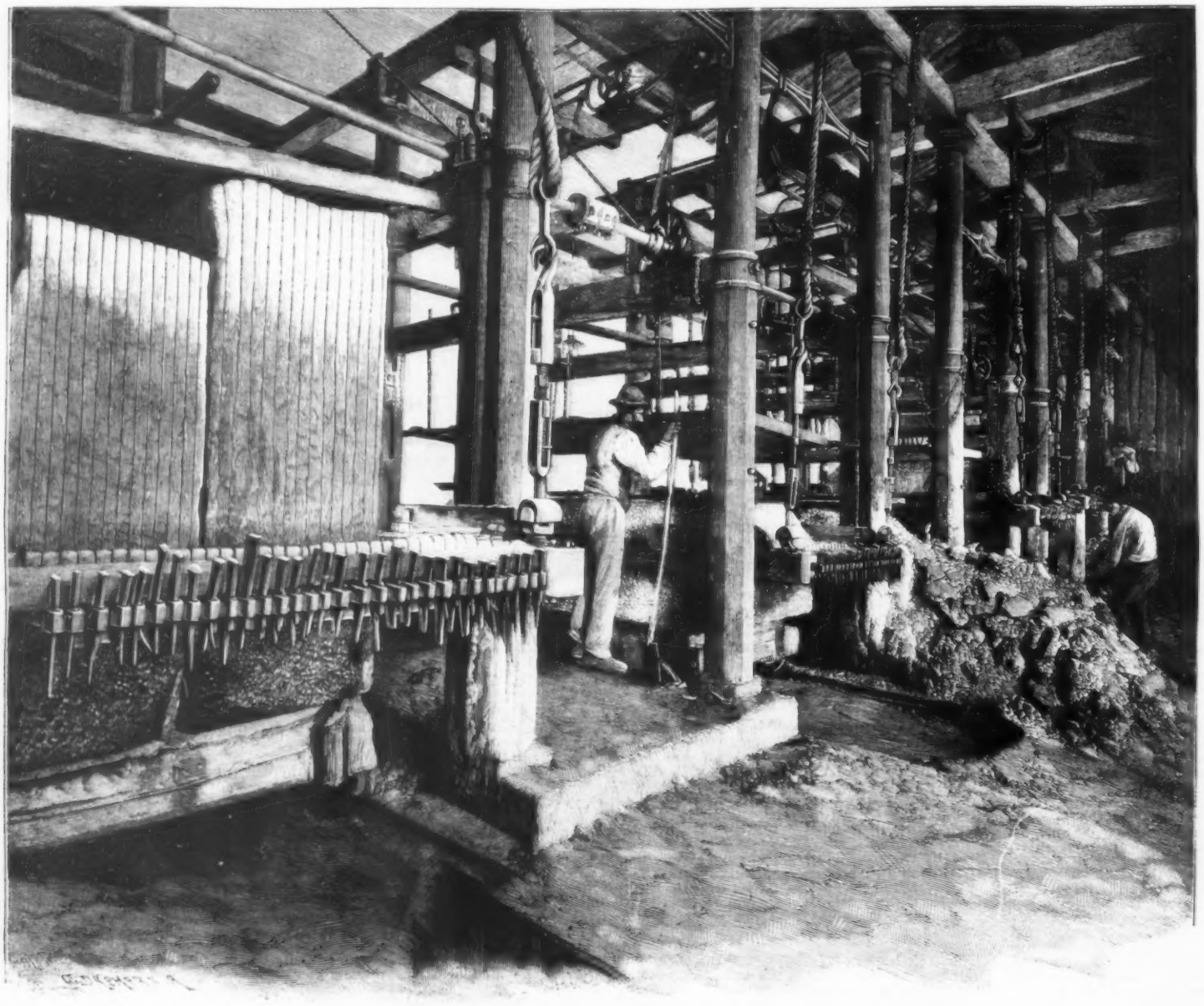
When we had reached Corvaja we were already in the mountains, and as we passed on we looked with astonishment at the wonderful mass of rocks with its hanging gardens, the stone terraces covered with ferns, the arched gateway through which can be seen more terraces that lead to the natural stone steps, and at the rough cliffs that stand out in the blue air high above these terraces. After a short journey we reached Serravezza. The little town lies just at the junction of the mountain streams Serra and Vezza, one of which comes from the ravines of Mount Altissimo and the other from Mount Valdarni. There is marble everywhere, the streets are snow-white, and we heard the same pounding and hammering there that is constantly heard at Carrara. When we were on the bridge that crosses the Vezza, by the first sawmill, a fine view opened before us. The narrow ravine is apparently closed by the pyramid of Monte Forato, immediately in front of which rises the dome-shaped top of a low mountain that looks so exactly like a tower that it seems as if it must have been built by the hand of man, and associates itself with the old story that Michelangelo intended to make a colossal figure of one of the Apuan Alps.

Both banks of the Vezza are lined with sawmills which vie with the rushing waters in making an uproar. Here also are quantities of marble, but the young growth covering the sides of the mountain, the brooks running down, the blossoming genista and the brownish green of the stone oaks soften the glaring whiteness of the stone. There is a slide of broken stone that reminds one of a glacier, and near by is the switchback railroad on which blocks are taken down from the heights above, and there is also a gigantic structure—abandoned iron works—that lies still and forsaken in the midst of the noisy activity. Back of Rosina the street leaves the bank of the Vezza and turns into the rough ravine of the Cansoli, the green waters of which are fed by broad brooks and thin, threadlike streams from all the rocks. The white summit, on the other side of which we shall descend, looks steep and unapproachable. The mills have followed us up to this wilderness, becoming smaller and more and more primitive as we have gone farther on. After leaving the last one, which is now a ruin, we find ourselves in absolute solitude, where we hear nothing but the noise of the brooks and the singing of the birds.

The ravine broadens and opens upon a great white slide, at the foot of which a stone hut nestles in the thin growth of trees and genista. A few workmen were busy there on the blocks of marble. This marble wilderness is called the Giardino (garden), a name which is comprehensible only when we contrast this region with the bare, sunburned mountain wall over



TRUCK FOR TRANSPORTING MARBLE SLABS.



INTERIOR OF MILL FOR SAWING MARBLE.

which we have to travel before reaching the dead-white marble tract on the other side of the tunnel. The narrow footpath, seemingly endless, resembles a winding staircase, and the precipices at our right become steeper and steeper and are seldom hidden from the eye by shrubs or heather. In the early morning the women of Rosina and Serravezza come up this steep ascent with food for their husbands in the quarries. They have fine, erect figures, and, although their feet are bare and they carry heavy baskets on their heads, they mount the stony path so easily that they almost seem to be flying. For city people, this climb is a difficult task.

Above opens the black entrance to the tunnel which leads to the marble quarry. An old man who lives here should supply travelers with lanterns, but this he grumblingly refused to do for us; so we decided to go without them. For twenty minutes we waded through unfathomable dirt in the darkness, the dampness dropping from the roof of the tunnel like rain. When about in the middle, where the daylight at the exit appeared like a small distant light, we had a most unpleasant adventure. Suddenly we heard a suspicious noise, the speck of daylight vanished, the ground under our feet shook and the whole tunnel was filled with smoke. No one had thought of the "marmifera," the immense traction engine used in these mountains. The thundering noise came nearer, a red eye glared at us through the darkness, we knew neither how large the engine was nor on which side of the tunnel it was coming. It was useless to call, because the noise would drown our voices. So we pressed ourselves flat against the wall, some turning their faces and some their backs to the unknown danger. Minutes passed thus, the smoke growing denser and denser, but suddenly the black colossus stopped near us. The man who ran ahead with the lantern had discovered us clinging to the wall like bats and freed us from our painful position.

Once in the daylight, the road to the Tagliate Quarry is easy; a bridge crosses the ravine of the Turrita Secca, the bed of which widens here so that it looks like the muddy bottom of a dried up mountain lake. On both sides of the entrance to the quarry are supporting pillars and long white walls built of layers of broken marble, and little huts of rough marble, also put together without mortar, are scattered here and there; even their roofs are made of slabs of marble, and one cannot look at them without thinking of the little sugar house of the witch in the never to be forgotten German fairy tale.

UNFINISHED STATUE OF ST. MATTHEW, BY MICHELANGELO.

TRANSPORTATION OF MARBLE BLOCKS.

The quarry may be entered without any danger, except that the floor has been made very slippery by the rolling of the stones. Great blocks of the blasted marble stood about, but they were worthless and were to be broken up and thrown down into the yawning abyss, which had already been partly filled up with the broken stone, thus forming the slide that might have been mistaken for a glacier. Pieces of rock were constantly falling from above, so that it was necessary to be on the alert every minute, always ready to jump out of the way. Upon the ridge were men with ropes fastened about them; they were laying a mine, but they were so far away that they looked tiny and their movements could not be followed. Fortune favored us. We learned from the superintendent, a weather beaten, white haired old man with a head that would have made a fine study for an artist, that an important event was about to take place. One of the greatest mines that had ever been laid in the mountain was to be exploded, a projection of rock was to be removed so as to lay open the finer stone that lies deeper; but as things would not be ready at once, we had time to look about us.

A white road winds between the wall of the mountain and the abyss, leading deep into the wonders of the white, cold marble world. Here slumbers the art work of the future! If one could only see through the mountain for a minute! It is filled with monuments and statues, kings and heroes, poets, thinkers and artists of the future ages are gathered together here! But it is here as in the world of men; from among many blanks one prize is drawn; and here, too, is many a one that will be run after for a time by those who have no discrimination, taking a place that should be filled by a better man. But, patience! The great ones for whom humanity waits are among them.

Finally the mine was ready. Before the fuse was lighted the man who laid the mine called down from the rocks in a voice that reached even the distant valleys and ravines, "Mine-hoo!" Then his assistants were seen hurrying away and in a moment the entire place was cleared. The superintendent made us go far back on the railroad where flat niches in the rock offered protection. Again the man who had laid the mine called out a ringing "Ho!" as a last sign that the fuse was burning, and then he climbed quickly over the summit of the rock behind which he hid himself, the rising smoke alone indicating the spot where he had been at work. Perfect silence reigned until the fuse had burned out and the smoke ceased. In a couple of seconds there was a loud report, the echo of which sounded from valley to valley, and we saw pieces of rock thrown into the air. Judging from the concussion, we thought that the whole angle of rock would fall, but inspection showed the work of the mine to have been quite insignificant.

The mountain had received us most hospitably, showing us all its wonders, and we had reason to be satisfied. Of course we had lanterns when we went back through the tunnel and consequently met with no more adventures. To avoid the steep "Giardino" in going back, we followed the fine road used by the ox teams and the traction engine. After we had gone a short distance we stopped surprised, the immense sweep of mountains at our feet was bounded far below us by a blue line, on which, with the aid of our glasses, we could distinguish moving objects; it was the sea with sails, the wide blue sea that awaited us. Our road led down to it and the sight seemed to give us wings. From the distance came the sound of evening bells and a peaceful valley beautiful with blossoming cherry trees invited us to descend.

But the mountain did not let us go until it had shown us another of its wonders. Half way down the mountain side is a little gray village—Terrinca is its name—where one stumbles and slides about its close narrow streets that are paved with sharp, pointed stones. Our tired minds were scarcely able to take any new impressions, but surprise awakened them. We were passing between two rows of little massive stone houses of the most astonishing architecture. Had they been built or hewn out of the living rock? That we could not tell, so gray and crumbling were the arches of the doors, the steps and pillars so overgrown with ferns. Many streets were entirely arched over so that the sun could never shine into them, and others were crossed by narrow stone bridges extending from the roofs on one side of the street to those on the other side.

Beautifully formed women carrying oddly shaped vessels on their heads walked over the sharp stones of the pavement in these streets with the greatest ease, in spite of the fact that their feet were bare. At last we came out of the twilight into the daylight again and found ourselves in a church square where all the young people of the village were enjoying an evening festival. The children had great wooden rattles in their hands and they received us with a most deafening noise. As if to complete the list of strange sights offered by this place, a madman suddenly rushed through the crowd of children, who ran more madly after him until the unfortunate disappeared at the church door. With a sort of horror we left this seemingly bewitched but rarely beautiful spot, and when once more under the spreading chestnut trees asked ourselves if the whole of Terrinca had not been a feverish dream caused by the overstrained condition of our tired nerves. We had forty minutes more of steep descent over a pavement that must have been conceived by an evil mind before we reached the Cansoli bridge, where we found the wagons that were to carry us to our lodgings at Fortedeimarmi.

On the Rosina road a last surprise presented itself to our tired eyes. There in the moonlight stood a lonely marble king as large as life, with a waving mantle, and a crown on his head, but his face was turned to the mountain wall. How he came there I do not know, but probably the stone had been badly cut and cast aside by the marble workers. The country became flatter and flatter, until there was a glimmering of something bright through the olive trees and the beating of the waves on the shore announced our approach to the sea. Fortedeimarmi lay before us, and its beach, strewn with marble blocks, looked in the quiet of the evening like a graveyard. Early next morning we saw

the marble loaded on the ship and then we said good-by to the marble mountain.

Michelangelo used to say that the statue was already in the rough stone and that it was only necessary to remove the shell so that it might appear. But to-day the first cutting is generally left to the assistant who mechanically cuts the stone away until he has obtained the outline of the plaster model, and then the master has only to put on the finishing touches. The Italian workmen are unsurpassed in their skill in thus preparing the blocks for the real sculptor. Occasionally a figure is cut directly from the marble without the help of the workman and it is delightful to watch the operation. At first the stone is as flat as a drawing, but gradually it falls away until the figure seems to stand in a box, and little by little that falls away too, leaving the statue unfettered. We have seen the birth of the masterpiece from the stone!—Ueber Land und Meer.

MINOR MINERALS AND METALS IN 1897.

ASBESTOS.—The production of asbestos in 1897 was 770 short tons, which was a very little more than in 1896. As in the previous year, this production was made chiefly in Georgia, where a true asbestos of short fiber is mined by the Sall Mountain Asbestos Company. A few tons were mined in California. A small amount of mineral was produced in Lawrence County, S. Dak., in 1896, by the Black Hills Asbestos Company, of Deadwood, but it made no output in 1897. A new discovery of asbestos was reported from the Chihuahua mining district, near Oak Grove, San Diego County, Cal., and samples have been sent us from the State of Washington, but there has been no production to speak of at any of these points. There is no doubt as to the existence of asbestos, either true asbestos or chrysolite, at many places in the United States, but the mineral is generally of poor quality—of short fiber, little strength and woody texture—or the deposits are so small and unfavorably situated that they cannot be worked profitably.

Recently a vein of silky asbestos of long fiber has been discovered in Georgia. This mineral is said to be the best yet found in the United States, but the vein has not yet been opened sufficiently to say how much of it there is.

The asbestos trade in the United States was quiet during the first half of the year, but improved in the autumn, and the prospects are now thought to be good.

The shipments of asbestos from Black Lake, Quebec, during the first ten months of 1897 amounted to 998,550 lb.; from Thetford Mines, 13,341,000 lb.; total, 14,339,550 lb., or 7,170 short tons, which shows a falling off from 1896, when the shipments for twelve months amounted to 10,380 short tons.

Barytes.—The production of barytes in the United States in 1897 was 27,316 short tons, against 21,900 short tons in 1896. The increase was due partly to the general improvement in business and partly to the advance in the duty on ground barytes under the terms of the Dingley law. The improvement in this trade was more marked in the East than in the Central States. The price of ground barytes in New York during the early part of the year was very low, No. 1 or refined barytes having been sold at $13 per ton, which was probably less than the cost of manufacture and transportation to New York. Since the new tariff has been in effect, however, imported barytes has been practically out of the market, and prices for the domestic article have advanced from 10 to 20 per cent., with a demand at the end of the year greater than the supply. Reports from St. Louis, the chief Western market, however, indicate that the trade in 1897 was only fair, with no improvement in prices. This difference between the New York and St. Louis markets is not incomprehensible, the latter never having been subject to the competition of the foreign product to the same extent as the former. At the works in St. Louis and vicinity ground barytes sold in 1897 at $11 per ton f. o. b. works. The Eastern market is supplied by grinders at Lynchburg, Va., and Hot Springs, N.C., who derive their supply of mineral from mines in the vicinity of Lynchburg, Hurt, Toshes, and Otter River, Va., and Sandy Bottom and Hot Springs, in North Carolina. A few tons were mined in 1897 at Del Rio and Woolf Creek, Tenn. The St. Louis grinders obtain mineral from the vicinity of Cadet, Old Mines, Mineral Point, Morreliton, and Potosi, Mo.

Bauxite.—The production of bauxite in the United States in 1897 was 18,000 long tons, against 17,096 long tons in 1896. In each year the product was derived entirely from Alabama and Georgia, the deposits of Arkansas and elsewhere remaining unworked. There are now four concerns engaged in the production of bauxite in the United States, one of them, the American Bauxite Company, of Rome, Ga., being a new comer in 1897; it purchased extensive bauxite beds in Floyd County, Ga., and has erected a washing plant for the preparation of the mineral. Nearly all the bauxite mining companies are now provided with plants of this kind, their development having been one of the especial features of the industry during the past two years, and it is recognized that the preparation of the mineral for market is a matter of considerable importance, requiring the supervision of a chemist. The export trade in bauxite, which was foreshadowed in our report for 1896, materialized in 1897, and a large quantity of the mineral was shipped by the Southern Bauxite Company.

The quotations of bauxite show a decline of from $10 per ton in 1891 to $7 per ton at the present time. The low price now received for the mineral after deducting the freight to consumers' works, which comes to about $5 per ton, and the considerable expense of preparing the mineral for market, explains why there is not greater competition in this industry.

Cement.—The production of Portland cement increased in 1897, as was foreshadowed in our report for 1896. The returns for 1897 indicate a make of 2,100,000 barrels of 400 pounds, against 1,032,654 barrels in 1896. This great increase was due to the continued displacement of foreign cement by that of domestic manufacture. The production of natural hydraulic cement in 1897 was 7,721,215 barrels of 300 pounds, against 7,454,611 barrels in 1896. Four works in the United States engaged in the manufacture of slag cement in 1897.

Mica.—The production of sheet mica in the United States in 1897 was 50,000 lb., against 8,000 lb. in 1896; the production of ground mica, mica scrap, etc., was 3,535 short tons, against 438½ short tons in 1896. The production of sheet mica in 1897 was made chiefly in New Hampshire, North Carolina and South Dakota, the amounts credited to each State being respectively 6,500 lb., 35,000 lb., and 8,500 lb. New Hampshire produced 4,278,000 lb. of ground mica, North Carolina 2,732,000 lb., and South Dakota 60,000 lb. The sheet mica of New Hampshire was marketed in Boston; that of North Carolina came chiefly to New York, some going to Chicago; while the South Dakota product (the output of one company) was divided between Chicago and St. Louis.

The New Hampshire mica was shipped from Bristol, Warren, Canaan, Grafton City and Rumney. The North Carolina product was obtained from Shelby and the mountain towns back of Asheville and Marion. The South Dakota mines are situated on French Creek, six miles east of Custer City. New discoveries of mica were reported in Lincoln County, Nevada, where a sample of 300 pounds, cut in sizes ranging from 2 by 5 in. to 9 by 10 in., was shipped, and at Chelan Falls, in Okanogan County, in Washington, whence a sample lot of about 700 pounds was taken out, though some of this would cut larger than 2½ by 3 in. In Salt Lake County, Utah, two mines were opened, in one of which there is considerable mineral disclosed, though but few perfect sheets larger than one inch square could be obtained; it was proposed, however, to use the product in a paint factory recently established in Salt Lake City. Some mica deposits were also discovered near Bloomingdale, in Passaic County, New Jersey, and steps were taken to mine this mineral for paint manufacture, though there was no production in 1897. In general there was no material change in the mica business in 1897, prices remaining about the same as in the previous year, notwithstanding the increase of duty according to the new tariff law. The supply of mica for the United States, as well as for the rest of the world, continues to be derived chiefly from India and Canada.

Nickel.—The total production of nickel in the United States in 1897 was 3,932,245 lb., against 3,696,939 lb. in 1896. In 1897, 2,015,192 lb. were in the form of metal, while 1,917,053 lb. were in the form of oxide, sulphide and salts, the figures for 1896 being respectively 1,600,049 lb. and 2,096,890 lb. Of the production in 1897, 33,700 lb. were of domestic origin. The Lancaster Gap mine, which was formerly a large producer, continued idle, and the remainder of the production of the nickel works of this country was derived from copper nickel matte imported from Sudbury, Ont. It is impossible at this time to give precise statistics of the world's production of nickel in 1897, but it is not likely that it was more than 4,500 metric tons, and in all probability it was less. Full particulars will be found in "The Mineral Industry," vol. vi, now in preparation.

Phosphate Rock.—The production of phosphate rock in the United States in 1897 was 890,000 long tons against 878,089 long tons in 1896. The increase was due entirely to Tennessee, where the production was 119,599 long tons, against 57,846 long tons in the previous year. Of the production in this State in 1897, 18,477 long tons are credited to the Centerville district and 101,122 long tons to Mount Pleasant. In both South Carolina and Florida the production fell off materially, the industry in those States suffering from the same conditions which caused the heavy falling off from 1895 to 1896. The Tennessee phosphates are being used largely in the manufacture of artificial fertilizers by various works in this country. This industry, which is growing rapidly, now involves a large amount of capital and is considered to be generally prosperous. It appears reasonable, moreover, to expect a steady improvement, as the use of artificial fertilizers will undoubtedly increase, the farmers of this country coming gradually to a realization of the necessity for it. There does not seem to be, however, much prospect of a speedy amelioration of the unfavorable conditions under which the greater part of the phosphate miners of Florida and South Carolina are laboring.

Platinum.—There is generally a small production of platinum to be reported in the United States, the metal being recovered at the San Francisco and Philadelphia mints in refining gold bullion from certain placer workings in California. In 1896 the production amounted to 200 troy ounces. Up to the end of October, 1897, no platinum had been recovered at either of these mints, but since the clean-up is made only occasionally, we enter the production in 1897 as 200 troy ounces. There was no production of platinum from Canadian matte, which contains a considerable percentage of it, and is a probable source of supply in the future. The production of platinum in Russia fell off considerably in 1897. But in Colombia there was an increase. There are no official statistics for the latter country, but our private information leads us to believe that the production in 1897 was 11,700 oz. troy, against 10,320 oz. troy in 1896. The price of platinum increased materially, owing to the diminution of supply and the increased demand, largely for use in Welsbach mantles, in which a comparatively large amount of platinum is now consumed. Refined platinum, in large quantities, can hardly be obtained at the present time for less than $15 to $16 per ounce.

Pumice.—There was a production of 1,700 short tons of pumice in the United States in 1897, which was mined at Black Rock, Millard County, Utah, and in Western Nebraska, the deposits at both places being operated by the Chicago Pumice Company. There was no production of this material in 1896, the establishment of the industry in this country dating back only to the beginning of 1897, although the existence of the mineral was known previously. Besides those mentioned, a deposit was opened in Idaho, but we are unaware of any production from the last. The Utah pumice is a highly siliceous, somewhat porous, volcanic rock; in quality it does not appear to compare favorably with the Italian mineral. The Nebraska pumice is a volcanic ash, which, according to Prof. E. H. Barbour, who described the deposits in the report of the Nebraska State Board of Agriculture for 1896 and in The Engineering and Mining Journal of November 6, 1897, is equal to the imported ground pumice of commerce, so far as the eye can determine. The product of the mines in both Utah and Nebraska is shipped to works in Chicago, where it is ground and otherwise prepared for market, the finished ground product selling there at $25 to $35 per ton. We are unable to distribute the production in 1897 according to States, but the greater part may be credited to Nebraska. Very little work was done at the Utah mines in the last portion of the year. The Utah mines are situated near the track of the Oregon Short Line Railway, but are 245 miles distant from Salt Lake City. The deposits which have been opened in Western Nebraska are situated directly on the line of the Chicago, Burlington & Quincy Railroad. There are numerous deposits in this part of Nebraska, and also in Northwestern Kansas, which have not been exploited.—Engineering and Mining Journal.

MICRO-PHOTOGRAPHS.

Translation by HENRY DIETRICH.

ALTHOUGH not so much in demand as in former years, these extremely small photographs, so often found in ivory watch charms, pen holders, etc., are inquired about quite frequently by professionals and amateurs. How are they made?

The instruments used are an objective of very short focus and a small camera with a movable holder. This camera and the original negative to be reduced are fastened to the opposite ends of a long, heavy board, says Anthony's Bulletin, similar to the arrangement in use for the making of lantern slides. The camera must be movable in the direction of the objective axis, and the negative must be fastened to a vertically stationary stand. It is then uniformly lighted from the reversed side by either daylight or artificial light. Some difficulty is experienced in getting a sharp focus of the picture. The ordinary ground glass cannot be used, not being fine enough, and the best medium for this purpose is a perfectly plain piece of glass, coated with pretty strongly iodized collodion, and sensitized in the silver bath, the same way as in the wet process. The focusing is done with a small lens or even with a microscope. The plate intended for the picture has, of course, to lie in exactly the same plane as the plate used for focusing. To be certain on this point, it is best to focus upon the picture plate, inserting for this purpose a yellow glass between objective and plate. If satisfactory sharpness has been obtained, the apparatus is once for all in order for these distances. Bromide of silver gelatine plates, on account of their comparatively coarse grain, are not suitable for these small pictures, and the collodion process has to come to the rescue.

Dagron, in Paris, a prominent specialist in this branch, gives the following directions: A glass plate is well rubbed on both sides with a mixture of 1 liter of water, 50 grammes powdered chalk, and 200 cubic centimeters of alcohol, applied with a cotton tuft, after which it is gone over with a dry cotton tuft, and thereafter cleaned with a fine chamois leather. The side used for taking the picture is then finally cleaned with old collodion. The collodion must be a little thinner than ordinarily used for wet plates. Dissolve:

Ether	400 c. c.
Alcohol	100 "
Collodion cotton	3 grammes.
Iodide ammonia	4 "
Bromide ammonia	1 "

The plate coated herewith is silvered in a silver bath of seven to eight per cent. From twelve to fifteen seconds are sufficient for this.

The plate is then washed in a tray or under a faucet with distilled water, to liberate it from the free nitrate of silver, and is afterward placed upon blotting paper to drip off. The still moist plate is then coated with the albumen mixture:

Albumen	150 c. c.
Add—	
Water	15 c. c.
Iodide potassium	3 grammes.
Ammonia	5 "
White sugar	2 "
Iodine	A small cake.

With a wooden quirl this is beaten to snow (foam) for about ten minutes, after which it must stand for fourteen hours, to settle. The albumen is poured on to the plate the same as collodion, and the surplus filtered back. After drying, the plate is laid for fifteen seconds in a silver bath, consisting of 100 cubic centimeters of water, 10 grammes nitrate of silver and 10 cubic centimeters of acetic acid. The plate is then carefully washed and left to dry. If carefully kept, it will retain its properties for years. To the second silver bath, when it assumes a dirty coloration, is added 25 grammes kaolin to each 100 cubic centimeters, by shaking the same well, and the bath is then filtered, after which a little nitrate of silver and acetic acid is added.

After each exposure the plate holder is moved a certain length, so that ten or more reproductions are obtained upon one and the same plate. The time of exposure depends upon the density of the negative and differs according to light. It varies between a second and a minute.

The developer is composed as follows:

Water	100 c. c.
Gallic acid	0·3 gramme.
Pyro	0·1 "
Alcohol	2·5 c. c.

The exposed plate is immersed in this bath, and after ten to twenty seconds, from 1 to 2 drops of a two per cent. nitrate of silver solution are added to each 100 cubic centimeters of the solution, whereby the picture becomes visible. To follow the process exactly, the plate has to be laid—in yellow light—under a weakly enlarging microscope, and only a few drops of the developer are put upon the same. As soon as the picture has reached the desired strength, it is rinsed and fixed in a fixing soda solution, 1:5. Ten to fifteen seconds are sufficient generally. Finally it is washed well.

After the drying of the plate, the several small pictures are cut with a diamond and fastened to the small enlarging lenses. For this purpose, the latter are laid upon a metal plate heated from underneath, a drop of Canada balsam is put to one end of the same, and, after it has become soft, the small diapositive is taken up with a pair of fine pincers, and is gradually put in contact with the fastener. Both glasses are then allowed to lie until the fastener has become hard. If bubbles appear, the whole method of fastening the picture has to be repeated.

ENGINEERING NOTES.

A curious difficulty has closed navigation on the Danube Canal, between Orsova and Turn Severin. The current is so strong that tugs are unable to draw ships through it.

France has succeeded in placing the first boat on Lake Tchad. The Marchand expedition to the Nile also carries a boat, the "Gen. Faidherbe," which is probably afloat now on the river above Khartoum.

According to a decision of the Supreme Court of Germany, it amounts to infringement to manufacture parts which obviously belong to a machine patented in Germany, even when it is proved that such parts are intended for exportation only to be used abroad in constructing the patented machine.—Centralblatt der Walzwerke.

In a recent paper on the "Action of Silicon upon Certain Metals," M. E. Vigouroux says: "The alkali metals, zinc, aluminum, lead, tin, antimony, bismuth, gold and silver, dissolve silicon more or less, but do not combine with it directly. Iron, chromium, nickel, cobalt, manganese, copper and platinum, on the other hand, form definite silicides."

The sailing of the steamship "Sahara" from New York is the beginning of a new service direct between that city and India. This vessel is one of a line which will make regular trips between the ports. A large portion of the cargo consisted of steel rails for an East Indian railroad, made by the Maryland Steel Company at Sparrow's Point. In spite of the fact that the company was obliged to make this shipment by way of New York, it was enabled to make a rate which could not be met by European rail plants, and thus secured the order.

Motor cycles are now being constructed in Italy propelled with acetylene gas, in the proportion of one-sixteenth of acetylene to fifteen-sixteenths of air. The motor weighs 19·8 pounds, works at 400 revolutions, and has a capacity of fifteen hours. It would appear from experiments that in the adaptation of acetylene to the ordinary gas engine no change in the mechanism is required, says Acetylene Gas Lighting. It is necessary, however, to considerably diminish the size of admission valves. It is asserted that acetylene gas is quite regular in working.

Germany's Baltic North Sea canal was used during the last business year by 8,287 steamers, averaging 1,700 tons, and by 11,673 sailing vessels, averaging less than 40 tons each. The total tonnage was 1,848,458, an increase of 345,000 over the year before. The average time of passage for steamers was 9 hours and 33 minutes; for tows it was 23 hours and 48 minutes. The receipts were 1,016,854 marks; the expenses, 2,074,792 marks. The mere cost of maintenance is double the total receipts, and there seems no likelihood of any large increase in receipts. Nine-tenths of the vessels using the canal were German.

Underwriters have learned by experience, says The Engineer's Gazette, that it is more economical to use steam than water for subduing fire on cotton carrying vessels, and have now at Galveston the fire protection boat "Cynthia," with steam always ready for action, night and day. A circular is issued to all masters of steamers arriving in the port, in which it is shown that in the case of the steamer "Maritime," in which the fire was subdued by water, the damage was $35,000, and nearly the entire amount was caused by water, while the losses on the steamer "Ribston" are less than $500, in this case steam being solely used to extinguish the fire.

The Boston Subway work is nearly completed. The Boston Transit Commission, in its annual report, says that the work still to be done lies in the section in Scollay Square, the section in Adams Square and the section north of Haymarket Square. Chief Engineer Howard A. Carson reports that 87 per cent. of the whole work is finished and 7 per cent. more is under contract or ordered. According to present prospects, the total cost of the improvement will fall considerably within the engineer's estimates. The total cost of the subway to date is $4,043,313.17, the original estimate being $5,000,000. A tunnel under the harbor to East Boston is again being discussed, at an estimated cost of $2,406,600.

Burglarproof mail cars have been built at the Topeka shops of the Atchison, Topeka and Santa Fé Railway, says Engineering News. They have no end platforms, and the doors are fitted with heavy bolts, bars and chains, while the windows and ventilators are fitted with bars. A secret receptacle has been provided for the safe carriage of registered letters. Besides these precautions against the entry of unauthorized persons, the cars in equipment and finish are model railway post offices. An extra amount of table room has been provided, the letter cases have patent roller label holders and wire bottoms. The cars are lighted with seven Pintsch gas lamps and there are fittings for temporary lights in case of emergency. The cars are 60 feet long and were built after designs furnished by the post office department.

A correspondent in Germany sends details of experiments made by Mr. H. Longchamps on friction driving to The Electrical Engineer. The arrangements of the test consisted of disks of various substances, such as leather, compressed paper and wood, mounted on a horizontal axis, running on a disk of cast steel mounted on a vertical axis. In this way the position of the friction disk on the surface of the cast steel disk varies the relative speeds of the two axles. This differential gear is exceedingly useful for driving machine tools by electricity, as minute changes of speed can be effected. The percentage efficiency of the combination with various powers and friction disks running on cast steel were as follows:

B. H. P. transmitted.	Leather.	Paper.	Wood.
0·5	52·84	52·05	52·53
1·0	65·49	64·70	65·61
1·5	73·16	72·65	73·40
2·0	71·93	76·44	76·88
2·5	71·08	73·30	.....

Experiments with a hardened steel disk running on cast steel gave no results, as power could not be transmitted by the combination.

MISCELLANEOUS NOTES.

The population of Germany increases at the rate of 600,000 a year.—Centralblatt der Walzwerke.

All state railway stations in Austria will soon be provided with racks for bicycles.—Journal des Sports.

The three English bicyclists who left London in July, 1896, for a ride across Europe and Asia have just arrived in Shanghai, having traversed 14,322 miles. They say the roads are very poor in the Celestial Empire, and that they were obliged to carry their wheels hundreds of miles on their backs. Armed with voluminous passports and red visiting cards several inches long, with their names in Chinese characters, they went from town to town, interviewing mandarins and missionaries, and living on pork and rice. They penetrated China from Upper Burma. Throughout the journey an officer rode on ahead, giving orders at all military posts that their safety should be looked after. The worst the cyclists had to contend against was the desire of the Celestials to show what they could do in the way of cycling.

Plumbiferous articles on rubber are injurious, and zinc oxide is injurious. Bulowski arrived at the following conclusions as a result of his researches: Rubber goods are not injurious if they are elastic and of rich consistency and swim in the water. A larger percentage of arsenic indicates a higher percentage of mineral constituents and consequently inferior goods. Black nipples are not injurious. Black dolls, which are dyed black in the mass, contain poisonous lead oxide. Red or red-brown dolls or rubber toys which are dyed in the mass may be considered as harmless. All gray rubber ware, especially such as is given to children to suck on, viz., nipples, etc., is relatively injurious, on account of containing zinc oxide. Further injury is done by some unscrupulous manufacturers who employ poisonous colors for decorating toys.

Few persons are aware of the existence of the Standard History of China, which is compiled in that country, and fewer still know how it is produced, says Industries and Iron. Ever since the Ham Dynasty, B. C. 206–A. D. 25, historians have been appointed to write the history of their times, and no eyes save their own see what they record. Each document as it is written is deposited in an iron bound chest which remains locked until the termination of the existing dynasty. Upon the accession of a new dynasty the chest is opened and the accumulated records are handed over to the existing historians, who forthwith compile therefrom the history of the country under the late line of rulers. In this way it is assumed that the virtues and vices of different rulers and the good or bad fortunes of the country while under their sway are impartially recorded.

Reports from Louisiana sugar planters indicate that the past season has been a profitable one. Practically all the plantations have finished their grinding and manufacturing of sugar and molasses and at present the outlook is for a crop of 325,000 to 360,000 tons, the same being slightly in excess of the crop for 1896 and nearly equaling the crop of 1894, which was the largest in the history of the State. The molasses yield, it is estimated, will be from 25,000,000 to 27,000,000 barrels, of which 6,000,000 will be open kettle of good quality and the remainder centrifugal molasses. The tonnage of cane was below the average, ranging from 18 to 23 tons an acre, but the yield of sugar has increased, being an average of 155 pounds a ton in Lafourche, 140 in West Baton Rouge, 180 in East Baton Rouge, 150 in Iberia, 160 in Iberville, 195 in St. Mary and 177 in Terrebonne, and 168 in the State. The average grade of sugar is better than last year, the price much advanced, and a good profit returned the sugar growers. The result has been an advance of from 20 to 25 per cent. in sugar property, many old plantations being brought under cultivation that have been idle since the civil war. Many plantations have already begun planting, and the acreage for the next crop will be increased, as compared with 1897, at least 18 per cent. Last year's acreage was about 8 per cent. above that of 1896.

The accompanying table, compiled by The American Land and Title Register, shows the total amount of real estate transfers at a number of the principal cities during the years 1896 and 1897:

Cities.	1896.	1897.	Per cent. Inc.	Per cent. Dec.
New York	$121,455,828	$94,284,663	..	22
Chicago	91,022,602	101,195,213	10	..
Philadelphia	84,832,729	87,058,644	2	..
St. Louis	46,726,843	56,436,427	15	..
San Francisco	12,903,242	15,238,323	15	..
Pittsburg	13,240,340	12,413,911	..	6
Detroit	14,332,533	14,516,221	1	..
Milwaukee	6,773,279	3,246,221	..	52
Minneapolis	8,452,867	7,838,345	..	7
Louisville	7,132,829	6,196,409	..	13
Omaha	8,016,663	5,890,636	..	26
St. Paul	4,296,018	4,576,098	6	..
Indianapolis	7,786,278	9,091,603	14	..
Portland	5,300,490	4,316,278	..	18
Duluth	4,503,841	3,090,112	..	31
Dallas	3,736,757	3,404,235	..	8
Los Angeles	15,837,111	12,445,960	..	21
Denver	8,869,789	9,107,599	2	..

The following table shows the total estimated cost of buildings for which permits were issued in a number of principal cities during the years 1896 and 1897:

Cities.	1896.	1897.
Chicago	$22,730,615	$21,777,230
Philadelphia	24,819,700	25,915,770
Brooklyn	14,996,578	18,765,813
Cincinnati	3,119,415	2,485,890
St. Louis	10,034,908	9,471,640
New Orleans	3,257,643	1,619,285
Pittsburg	5,591,309	6,295,118
Detroit	5,465,228	4,385,840
Minneapolis	2,814,928	1,591,330
Omaha	2,402,591	1,468,776
St. Paul	1,753,962	1,424,274
Denver	1,305,872	1,267,300
Indianapolis	2,387,864	3,445,047
Duluth	570,962	283,309
Kansas City	1,900,458	1,848,390
Los Angeles	3,034,175	3,660,075

SELECTED FORMULÆ.

Detection of Formaldehyde in Milk.—Denigés (Jour. Phar. Chim.) recommends the following method: To 10 cubic centimeters of milk add 1 cubic centimeter of fuchsine sulphurous acid, allow to stand five minutes, then add 2 cubic centimeters of pure hydrochloric acid and shake. If formaldehyde is not present, the mixture remains yellowish-white, while if present a blue-violet color is produced. This test will detect 0·02 gramme of anhydrous formaldehyde in one liter of milk.

Acid Resisting Asbestos.—F. Schrader, in Chemiker Zeitung, 1897, 285, states that asbestos fabrics to resist acids, such as are required in the chemical industry, should be made of hornblende asbestos, in which the proportion of bases to silica is as 1 : 1, or of the formula $RSiO_3$ (R being mostly magnesia). Asbestos of the composition 3 : 2 (that is to say, serpentine asbestos) is attacked by very weak acids, like acetic acid.

New Alloys.—At a recent meeting of the American Foundrymen's Association, Mr. F. J. Davis stated that the use of ferro-manganese in making manganese bronze was objectionable, owing to the iron introduced, but this objection can be avoided by the adoption of a rich alloy of copper and manganese, now obtainable commercially, by the use of which a very pure series of manganese bronze can readily be produced. One of the best of these, suitable for gun wheels, propellers and mining machinery, had the following composition: Copper, 53 per cent.; zinc, 42 per cent.; manganese, 3·75 per cent.; aluminum, 1·25 per cent. The absence of iron permits the use of the large proportion of zinc without risk of rendering the metal brittle. The addition of the aluminum was necessary with the above alloy, as otherwise it was difficult to obtain sound castings. By varying the above proportions an excellent substitute for German silver could be obtained, having the following composition: Copper, 67·25 per cent.; manganese, 18·50 per cent.; zinc, 13 per cent.; and aluminum, 1·25 per cent. The metal thus produced is said to be as strong as German silver and makes better castings, while it is less liable to corrosion. Its electrical resistance is four times as great as that of the older alloy.

Liquid Stove Polish.—For a liquid stove polish try the following:

Copperas	10 parts.
Bone black	5 "
Graphite, in powder	5 "

Water sufficient to make a paste. The addition of a small amount of alum to this is said to improve it.

Another cheaper formula is as follows:

Soap, common yellow	10 parts.
Resin, in powder	5 "
Water, sufficient.	

Bone black or plumbago, sufficient. Mix the resin and the soap (the latter finely shaved), add 40 parts of boiling water and heat until a homogeneous mixture is obtained.

Stir in the blacking material and remove from the fire. Test a small portion, and then dilute with boiling water to suit.

If cost is no object, the following will prove all that can be desired:

Bayberry wax	10 parts.
Plumbago, in fine powder	200 "
Coal oil, sufficient.	

Melt the mineral wax with a portion of the oil over a water bath, and pour the product into the rest of the oil, stirring well. Grind up the plumbago with the product, adding a little at a time, until you arrive at the desired consistency.—National Druggist.

Manufacture of Matches.—Each factory uses its own methods and chemical mixtures, though, in a general way, the latter do not vary greatly. It is impossible here to give a full account of the different steps of manufacture, and of all the precautions necessary to turn out good, marketable matches. However, in the manufacture of the ordinary safety match, the wood is first comminuted and reduced to the final shape and then steeped in a solution of ammonium phosphate (2 per cent. of this salt with 1 or 1½ per cent. of phosphoric acid), or in a solution of ammonium sulphate (2½ per cent.), then drained and dried. The object of this application is to prevent the match from continuing to glow after the match has been burned out. Next the matches are dipped into a paraffin or stearin bath, and after that into the match bath proper, which is best done by machines constructed for the purpose. Here are two formulas for the "composition:"

(1.)	Potassium chlorate	2,000 parts.
	Lead binoxide	1,150 "
	Red lead	2,500 "
	Antimony trisulphide	1,250 "
	Gum arabic	670 "
	Paraffin	250 "
	Potassium bichromate	1,318 "
(2.)	Potassium chlorate	2,000 "
	Lead binoxide	2,150 "
	Red lead	2,500 "
	Antimony trisulphide	1,250 "
	Gum arabic	670 "
	Paraffin	250 "

Rub the paraffin and antimony trisulphide together, and then add the other ingredients. Enough water is added to bring the mass to a proper consistency when heated. Conduct heating operations on a water bath. The sticks are first dipped in a solution of paraffin in benzine and then are dried. For striking surfaces, mix 9 parts red phosphorus, 7 parts pulverized iron pyrites, 3 parts pulverized glass, and 1 part gum arabic or glue, with water, q. s. To make the matches water or damp proof, employ glue instead of gum arabic in the above formulas and conduct the operations in a darkened room. For parlor matches dry the splints and immerse the ends in melted stearine. Then dip in the following mixture and dry:

Red phosphorus	3 parts.
Gum arabic or tragacanth	0·5 "
Water	3 "
Sand (finely ground)	2 "
Lead binoxide	2 "

Perfume by dipping in a solution of benzoic acid.—Pharmaceutical Era.

HOW MUCH SLEEP DO WE NEED?

PROBABLY the answer to this question must be worked out by each one for himself; but it is quite certain that with some persons sleep is not absolutely necessary to hard and prolonged work. A number of instances illustrating this are given in a brief note in The British Medical Journal, a part of which we quote below:

"Sir James Sawyer, who has lately been discoursing on longevity to the members of the Acock's Green Institute, Birmingham, rightly insisted on 'a sufficiency of sleep' as one of the things needful to make a man's days long in the land. But what is 'a sufficiency'? Sir James defines it as one-third of the twenty-four hours. For what Matthew Arnold called the 'average sensual man,' that is to say, the man of normal physiological needs and cravings, this amount is probably not too much. But some of the greatest workers of our day have done with much less than eight hours of sleep. Dr. James Legge, professor of Chinese in the University of Oxford, who has just died at the age of eighty-two, was, it is said, in the habit of rising at 3 A. M., and allowed himself only five hours of sleep. Brunel, the famous engineer, for a considerable part of his life worked nearly twenty hours a day; friends and assistants have left it on record that he hardly ever went to bed, and yet never seemed tired or out of spirits. After working through a great part of the night, he slept in his armchair for two or three hours, and at early dawn he was ready for the work of the day. Sir George A. Elliott, afterward Lord Heathfield, who was in command throughout the great siege of Gibraltar, which lasted four years, never during all that time slept more than four hours out of the twenty-four. He lived to the age of eighty-four. In a recent number of Cosmopolis Prof. Max Müller records a conversation which he had with Alexander von Humboldt on the subject of sleep. 'As I get old,' said Humboldt, 'I want more sleep—four hours at least. When I was young, two hours of sleep were quite enough for me.' On Prof. Max Müller hinting that he found this a hard saying, Humboldt said: 'It is quite a mistake, though it is very widely spread, that we want seven or eight hours of sleep. When I was your age, I simply lay down on the sofa, turned down my lamp, and after two hours' sleep I was as fresh as ever.' He lived to be eighty-nine. Littré gives the following account of his labors during the printing of his dictionary, which was thirteen years in passing through the press: 'My rule of life included the twenty-four hours of the day and night, so as to allow the least possible amount of time to the current calls of existence. . . . I rose at 8—very late, you will say, for so busy a man. Wait an instant. While they put my bedroom in order, which was also my study, I went down stairs with some work in hand. It was thus, for example, that I composed the preface of the dictionary. I had learned from Chancellor d'Aguesseau the value of unoccupied minutes. At 9 I set to work to correct proofs, until the hour of our midday meal. At 1 I resumed work and wrote my papers for the Journal des Savants, to which I was from 1855 a regular contributor. From 3 to 6 I worked on the dictionary. At 6 punctually we dined, which took about an hour. They say it is unwholesome to work directly after dinner, but I never found it so; it is so much time won from the exigencies of the body. Starting again at 7 in the evening, I stuck to the dictionary. My first stage took me to midnight, when my wife and daughter (who were my assistants) retired. I then worked on till 3 in the morning, by which time my daily task was usually completed. If it was not, I worked on later, and more than once, in the long days of summer, I have put out my lamp and continued to work by the light of the coming dawn. However, at 3 in the morning I generally laid down my pen and put my papers in order for the following day, that day which had already begun. Habit and regularity had extinguished all excitement in my work. I fell asleep as easily as a man of leisure does, and woke at 8 as a man of leisure does.' Littré was past forty when he began this work, he was fifty-nine when he began to print the dictionary, he was seventy-two when he completed it, and he lived to be nearly eighty. These examples may, to use the consecrated phrase of the hagiographers, be more for admiration than for imitation; but they serve to show that longevity and a small allowance of sleep are not in all cases incompatible."

TRANS-MISSISSIPPI AND INTERNATIONAL EXPOSITION AT OMAHA.

THE Trans-Mississippi and International Exposition will open its gates in the metropolis of Nebraska, June 1, 1898, and continue for five months. It will for the first time adequately reveal the wealth and resources of the western world. This exposition had its origin in resolutions adopted by the Trans-Mississippi Commercial Congress at Omaha, in 1895, representing twenty-four States and Territories. The Exposition is controlled by a corporation known as the Trans-Mississippi and International Exposition, with a capital of $1,000,000. The management is vested in a directory of fifty members, with an executive committee of six department managers. Each department is divided into appropriate bureaus, in charge of experts in their respective branches. In addition to the stock subscriptions, revenues aggregating not less than $1,000,000 from various sources have been assured. Under an act of Congress the enterprise is granted recognition as a national and international exposition, with privileges for the admission of foreign exhibits free of duty, the right to strike memorial medals through the United States mints, and all other privileges heretofore granted to international expositions. The government has erected a large building and will place therein a government exhibit. The bill carried an appropriation of $200,000. The Secretary of the Treasury has issued official orders covering the regulations under which foreign exhibitors may participate. By direction of President McKinley the State Department has extended invitations to the rulers of foreign nations, soliciting them to participate. A commission appointed by the President will collect the materials for a magnificent government exhibit.

Nebraska has appropriated $100,000, Illinois $45,000, Montana $30,000, and Colorado, Utah, Iowa and other Western States have made appropriations and are preparing extensive exhibits. In Nebraska and adjoining States there is an aggregate population of over 9,000,000. The managers of the Exposition estimate the total attendance will be not far from 2,500,000.

The city of Omaha has contributed $30,000, through its park commission, and will doubtless increase this sum to a total of $100,000 by expenditures for beautifying and improving the Exposition grounds and approaches thereto before the opening day of the Exposition, while Douglas County, of which Omaha is the seat, has authorized an issue of $100,000 in Exposition bonds.

The Exposition grounds are within the city limits on the north side.

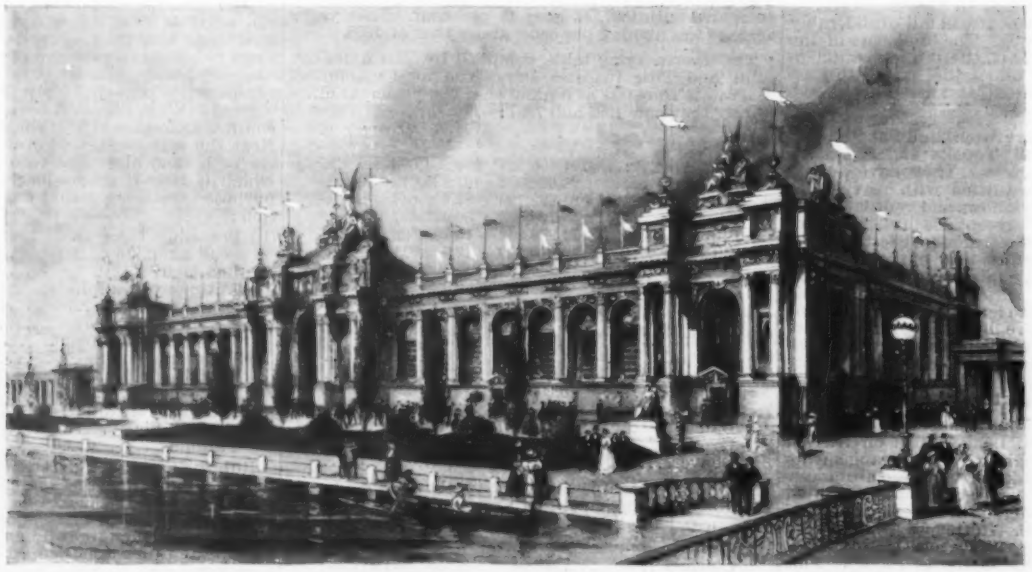
The main entrance is on the south side, at the intersection of Twentieth Street, through the Arch of States into the Grand Canal Court. This arch, one of the most noticeable in the groups of structures, is decorated with a frieze composed of the arms of the Trans-Mississippi States, the whole being surmounted by sculpture figures bearing the United States shield. A lagoon extends the entire length of the tract.

BIRD'S EYE VIEW OF THE TRANS-MISSISSIPPI AND INTERNATIONAL EXPOSITION.

The great buildings of the Exposition are situated on either side of the lagoon, between Sherman Avenue and Twenty-fourth Street, as follows: Agriculture, Fine Arts, Electricity and Machinery, Mines and Mining, Liberal Arts, Manufactures and the Auditorium. At the west end is the Government building. On the north line, facing the lagoon at the intersection of Twentieth Street, stands the Administration building. The arch of the States forms the main entrance to the grounds at the intersection of Twentieth Street. The Horticulture, Dairy, Apiary, Poultry, and the various State buildings are located on the bluffs tract, east of the Grand Court. The estimated expenditures for preparation and embellishment of the grounds and the construction of buildings approximate $1,200,000.

At the extreme west end of the lagoon the water spreads out either way into a broad basin, a trefoil in plan, lying directly before the Government building, and surrounded by a peristyle of double columns, forming shady promenades on both sides. These colonnades converge toward the west, the false perspective tending greatly to magnify the extent of water and open space beyond. Here the sculptured architecture is everywhere doubled in effect by reflection.

Under the Department of Exhibits the following subdivisions or bureaus have been created, viz.: Agriculture, Horticulture, Forestry, Irrigation, Live Stock and



OMAHA EXPOSITION—AGRICULTURE BUILDING.

Dairy, Mines and Mining, Liberal Arts, Manufactures, Fine Arts, Education. The sections devoted to Machinery and Electricity are in charge of commissioners. The Bureau of Fine Arts is under the direction of the Western Art Association. The Bureau of Education is under the superintendency of the Woman's Board. Manufactures, Mines and Mining and Liberal Arts are under the direct control of the manager of the department.

Nearly eighty acres of land at the north end of the vast inclosure has been set apart for a racing course, live stock stalls, a ten acre irrigating exhibit in operation, agricultural exhibits, etc. In fact, agriculture and live stock are prominent features of the Exposition.

All the agricultural products will be shown in a way to set forth their value and the proportionate part they take in the products of the West. The various branches, Dairying, Horticulture, Poultry, Stock Growing, etc., will be cared for in separate buildings specially erected for and adapted to them.

The beet sugar industry will be displayed in a most graphic manner. No other exposition has ever given so much space proportionately to the horticultural exhibit, and especially to the fruit growing industry.

In pursuance of the original plan, efforts are being put forth to present a collective mining exhibit which shall excel any former exposition of the products of American mines.

The northern extremity of the bluff tract is connected with the main grounds by a viaduct over Sherman Avenue leading to a large area devoted to concessionaires. There will be exhibitions of mechanical novelties in infinite variety. An interesting feature will be Cripple Creek in miniature, an exact reproduction of the famous Cripple Creek mining camp. The concession for Cripple Creek occupies 15,000 square feet. The Afro-American village will be illustrative of every phase of life among the negroes of the South. Among other attractions are: The Baby Incubator; Irish, Tyrolean and Moorish Villages; Old Vienna; reproduction of Marcusplace, Venice; Old English County Fair; Hagenbeck's Animal Show; Wild West Show; Moqui Indian Snake Dance; Cyclorama of the Battle of Lookout Mountain; the Scenic Railway, moving picture features, etc. An attractive feature of the amusement section will be Sherman's Umbrella, a massive mechanical invention by which passengers are elevated to a height of 300 feet and revolved slowly within a circle whose diameter is 250 feet. At night the tower will be brilliantly illuminated by electricity, while at the apex a powerful searchlight will be placed.

One of the features will be a reproduction, historically correct in all its details, of the last great council of the amalgamated tribes of the Kiowas and Apaches, held in June, 1867. The encampment, which at the time the council was held covered a circle of country ten miles in extent, will occupy four acres of ground at the Exposition. The encampment will consist of 250 tepees.

Officers: Gurdon W. Wattles, president; Alvin Saunders, resident vice-president; Herman Kountze, treasurer; John A. Wakefield, secretary; Carroll S. Montgomery, general counsel.

OMAHA EXPOSITION—MANUFACTURES BUILDING.

RAILROAD ACCIDENT AT PÉAGE, FRANCE.

IN the night between the twenty-fourth and twenty-fifth of December, at a quarter past one o'clock, express train No. 10, from Marseilles to Paris, was stopped on the open track by a brake accident between Péage and Clovas, when it was run into by express train No. 20, which was following at a few minutes' interval. The shock crushed the last two cars but one of train No. 10. Three passengers were instantaneously killed, and thirteen others were seriously wounded. The manager of L'Illustration, who was aboard the telescoped train, was enabled at daybreak to take a photograph representing the last four cars of this train and the locomotive of the telescoping one. At this moment (half past seven in the morning) the work of clearing the track had already begun by the throwing of a part of the wreckage down the embankment, but the cars that remained entire and the locomotive of the telescoping train were still in the same place that they occupied at the time of the collision.

The photograph here reproduced brings into relief certain interesting peculiarities that necessitate a few explanations.

In the first place, it will be remarked that the locomotive of the colliding train remained nearly intact. It is an engine of the style that has been in use upon the Paris-Lyons-Mediterranean line for some years, and the front of which terminates in a point, so as to present less resistance to the wind. A twisted buffer and a few indented plates were all that there was to show the damage done to it, notwithstanding the terrific blow that it gave to the train ahead.

What is still more extraordinary is that, while the last two cars but one of the train struck were crushed, the last of all, the baggage car, which received the first blow, merely had its roof raised and remained upon the track. Finally, the fourth car (seen to the right of the engraving) remained intact, and the passengers that it contained were unharmed, while a few yards behind, three unfortunates met with death amid a chaos of debris.

To sum up: (1) The locomotive of the colliding train, which was very massive and heavy, remained nearly intact; (2) the heavily loaded, iron-framed rear baggage car of the wrecked train resisted the direct impact; (3) an old style, wooden framed car of the Compagnie du Nord was smashed; (4) a P.-L.-M. car of intermediate model had its box broken to pieces, while its frame, which was of iron, remained entire; (5) a long P.-L.-M. car, with central passageway (American style), with iron plate frame, new model, was scarcely damaged.

From these phenomena, affirmed by the testimony of the photograph, arises, it seems to us, a law that might be formulated as follows: the heavier and more rigid a car is, the more security it assures in case of a collision.

After the very natural excitement caused by this accident has subsided, we think that it will be well to meditate upon this object lesson given by so cruel an experience.

As for the prime cause of the accident, the inquest will probably, as usual, descant upon the errors committed by subaltern employés. Now, has not the management of the company assumed a great part of the responsibility by organizing a service in which fast running trains succeed each other at so short intervals? It will probably be answered that every precaution is taken, and that if, despite the guarantees of the block system, a fast train can come up with another, it can with stronger reason overtake those running more slowly among all that move upon a greatly crowded line. This is disputable; but, putting the question of safety aside, is it not absurd to dispatch two trains, having exactly the same itinerary, every day almost at the same hour? And, to look at the convenience of the public merely, would it not be better to space them six hours apart, for example, so as to permit passengers to take advantage of more conveniently distributed starting times?—L'Illustration.

Locomotive of the colliding train. Baggage car of the wrecked train. Débris of a first-class car of the Company of the North. Frame of a first-class P. L. M. car. P. L. M. passenger car.

RAILROAD ACCIDENT AT PÉAGE, FRANCE.

Hamburg, the German seaport, has a population of about 700,000; with Altona and other surrounding towns, it amounts to over a million.—La Vie Scientifique.

THE PHILOSOPHY OF HYPER-SPACE.*

THERE is a region of mathematical thought which might be called the fairyland of geometry. The geometer here disports himself in a way which, to the non-mathematical thinker, suggests the wild flight of an unbridled imagination rather than the sober sequence of mathematical demonstration. Imaginative he certainly does become, if we apply this term to every conception which lies outside of our human experience. Yet the results of the hypotheses introduced into this imaginary universe are traced out with all the rigor of geometric demonstration. It is quite fitting that one who finds the infinity of space in which our universe is situated too narrow for his use should, in his imaginative power, outdo the ordinary writer of fairy tales, when he evokes a universe sufficiently extended for his purposes.

The introduction of what is now very generally called hyper-space, especially space of more than three dimensions, into mathematics has proved a stumbling block to more than one able philosopher. The question whether a fourth dimension may possibly exist, and whether it can be legitimately employed for any mathematical purpose, is one on which clear ideas are not universal. I do not, however, confine the term "hyper-space" to space of more than three dimensions. A hypothesis, which is simpler in its fundamental basis, and yet seems absurd enough in itself, is that of what is sometimes, improperly I think, called curved space. This also we may call hyper-space, defining the latter in general as space in which the axioms of the Euclidean geometry are not true and complete. Curved space and space of four or more dimensions are completely distinct in their characteristics, and must, therefore, be treated separately.

The hypothesis of a fourth dimension can be introduced in so simple a way that it should give rise to no question or difficulty whatever. Indeed, the whole conception is so simple that I should hardly deem it necessary to explain the matter to a professional mathematical student. But as we all have to come in contact with educated men who have not had the time to completely master mathematical conceptions, and yet are interested in the fundamental philosophy of our subject, I have deemed it appropriate to present the question in what seems to me the simplest light.

The student of geometry begins his study with the theory of figures in a plane. In this field he reaches certain conclusions, among them that only one perpendicular can be drawn to a line at a given point, and that only one triangle can be erected with given sides on a given base in a given order. Having constructed this plane geometry, he passes to geometry of three dimensions. Here he enters a region in which some of the propositions of plane geometry cease to be true. An infinity of perpendiculars can now be drawn to a given line at a given point, and an infinity of triangles can be constructed on a given base with given sides. He has thus considered in succession geometry of two dimensions, and then passed to geometry of three dimensions. Why should he stop there? You reply, perhaps, because there are only three dimensions in actual space. But in making hypotheses we need not limit ourselves to actualities; we can improve our methods of research, and gain clearer conceptions of the actual by passing outside and considering the possible.

For logical purposes there is no limit to the admissibility of hypotheses, provided we consider them purely as hypotheses, and do not teach that they are actual facts of the universe. It is, therefore, perfectly legitimate to inquire what our geometry would be if, instead of being confined to three dimensions, we introduced a fourth. Many curious conclusions follow. When we are confined to a plane, a circle completely bounds a region within the plane, so that we cannot pass from the inside to the outside of the circle without intersecting it. Being conscious only of two dimensions, and moving only in two dimensions, and placed inside such a material circle, they would find themselves completely imprisoned, with no possibility of getting outside. But give them a third dimension, with the power to move into it, and they simply step over the circle without breaking it. They do not have to even touch it. Living as we do in space of three dimensions, the four walls, pavement and ceiling of a dungeon confine a person so completely that there is no possibility of escaping without making an opening through the bounding surface. But give us a fourth dimension, with the faculty of moving into it, and we pass completely outside of our three dimensional universe, by a single step, and get outside the dungeon as easily as a man steps over a line drawn on the ground. Were motion in the fourth dimension possible, an object moving in that dimension by the smallest amount would be completely outside of what we recognize as the universe, and would, therefore, become invisible. It could then be turned around in such a way that on being brought back it would be obverted, or appear as in a looking glass. A man capable of such a motion would come back into our sight similarly obverted, his left side would now be his right, without any change having taken place in the relative positions of the particles of his body. The somerset he would have turned would have completely obverted every atom and molecule of his body without introducing any disturbance into its operations.

This possibility of obversion brings in a curious question concerning the rigor of one of the fundamental propositions in elementary geometry. Euclid proves by superposition that the two triangles in a plane having two angles and the included side equal, are equal to each other. In the demonstration it is assumed that the triangles can be made congruent by simply placing one upon the other without taking it out of the plane. From this the conclusion is drawn that the same conclusion holds true if one of the triangles be obverted. But in this case they cannot be brought into congruence without taking one of them out of the plane and turning it over. The third dimension is thus assumed in geometry involving only two dimensions.

Now consider the analogous case in space. Two pyramids upon congruent bases may be proved equal by bringing them into congruence with each other. But suppose that they differ only in that one is the obverse of the other, so that they could be brought into congruence only by looking at one of them in a mirror and then placing the other into congruence with the image of the first as seen in the mirror. Would we detract from the rigor of the demonstration by assuming the possibility of such an obversion without changing the volume of the pyramid? With a fourth dimension we should have no detraction from rigor. We would simply obvert the pyramid as we would turn over the triangle.

The question of the fourth dimension as a reality may be considered from two points of view, its conceivability and its possble objective reality. If by conceivability we mean the power of being imaged in the mind, it must be admitted that it is absolutely inconceivable. We have no difficulty in forming a visual conception of three lines passing through the same point, each of which is at right angles to the other two. Such is the familiar system of co-ordinate axes in space. But he who would conceive a fourth dimension must be able to imagine a fourth axis perpendicular to all three of the others. This clearly transcends all possibility even of imagination. The fourth dimension in this sense is certainly inconceivable.

The question of the objective possibility of the fourth dimension is quite a distinct one from that of its conceivability. The latter limitation upon our faculties grows out of the objective fact that we and our ancestors have had no experience of a fourth dimension; that we have always lived in a universe of three dimensions only. But we should not too readily conclude that all being is necessarily confined to these three dimensions. Those who speculate on the possible have taken great pleasure in imagining another universe alongside of our own and yet distinct from it. The mathematician has shown that there is nothing absurd or contradictory in such a supposition. But when we come to the question of physical fact, we must admit that there appears to be no evidence of such a universe. If it exists, none of its agencies intrude into our own universe, at least in the opinion of sober thinkers. The intrusion of spirits from without into our world is a favorite idea among primitive men, but tends to die out with enlightenment and civilization. Yet there is nothing self-contradictory or illogical in the supposition. The fish that swims the ocean experiences objects which, to him, seem to come from outside his universe, steamships for example. If our atmosphere had been opaque to the rays of light from the sun, or even if it had been so filled with clouds and vapor that we could never see outside of it, we also should have had a similar experience. But we may be said, in a certain sense, to see through the whole of our conceivable space with the aid of our telescopes, and the general tendency of scientific thought at the present time is toward the conclusion that no natural agency of which we can trace the operation originates outside the space into which our telescopes may penetrate. Our universe forms, so to speak, a closed system. This is true apparently even of agencies so subtile as those which give vibrations to ether. If there is any agency which we could imagine to connect us with an outside sphere, it is certainly the luminiferous ether. But should this ether enter into a fourth dimension, the intensity of light and radiant heat would diminish as the cube of the distance and not as the square. To speak more accurately, radiance emanating from an incandescent body would be entirely lost—would pass completely out of our universe. The fact that it is not lost, and indeed the general theory of the conservation of energy, shows that there is no interchange of energy between our universe and any possible one lying in another dimension of space.

We may regard the limitation of the dimensions of space to three as expressing in a certain way a physical fact. Our conception of space is originally based upon the possibility of motion. The threefold possibility of relative motion can be reduced to a physical fact in this way: Let a point be fixed at one end of a rod, the other end of which is immovably fixed to a wall. The point can then have motion over the surface of a sphere whose center is at the fixed point and whose radius is the length of the rod. Now fix one end of a second rod to another point of the plane and bring the two ends of the rods together, and fix the point on both ends; then the point can only move in a circle. Fasten it to a third point of the plane with a third rod, and it cannot move at all. But if we add a fourth dimension, it could move.

The limits of space are for us simply the limits of possible motion of a material body. We can imagine a body coming from any point in three dimensional space to us, but cannot imagine one coming from outside of such space, until we add a fourth dimension.

Our conclusion is that space of four dimensions, with its resulting possibility of an infinite number of universes alongside of our own, is a perfectly legitimate mathematical hypothesis. We cannot say whether this conception does or does not correspond to any objective reality. What we can say with confidence is that, if a fourth dimension exists, our universe and every known agency in it is, by some fundamental law of its being, absolutely confined to three of the dimensions. But we must not carry a conclusion of this sort beyond the limits set by experience. When we say that experience shows that not only our material universe, but all known agencies in it, are, by a law of their being, incapable of motion in more than three dimensions we must remember that the conclusion applies only to those motions which our senses can perceive, the motions of masses, in fact. There is no proof that the molecule may not vibrate in a fourth dimension. There are facts which seem to indicate at least the possibility of molecular motion or change of some sort not expressible in terms of time and three co-ordinates in space. If we consider those conceptions of mechanics which we derive from visible phenomena to afford a sufficient explanation of molecular action, we must admit that, when the position and motion of every atom of a given substance are defined, the chemical properties of that substance are completely determined. If we take two collections of atoms of the same substance, put them together in the same way and endow them with the same kinds of vibratory motion, we ought, on any mechanical theory of matter, to obtain substances of identical properties. Now, there seem to be reasons which I cannot stop at present to develop that might make us believe in changes of properties and attributes of substances not completely explained by molecular changes. That such is the case with vital phenomena can be demonstrated beyond doubt; that it is the case with chemical phenomena when they approach the vital character seems very probable. Certainly, there is some essential difference between that form of molecular motion in which heat is commonly supposed to consist and the motion of masses.

Perhaps the most remarkable of these differences consists in the relation of this motion to the ether. The motion of a mass suffers no resistance by passing through the ether with the highest astronomical velocities. Matter so rare as that of the diffuse comets may move around the sun with a speed of many miles per second without suffering the smallest resistance from the ether—in a word, without any friction between the matter and the ether. But when the molecules have the motion of heat, that motion, if motion it be, is always communicated to the ether and is radiated away from the body, which thus becomes cool. Whatever form we attribute to the energy of heat, it is certainly a form which is constantly communicated from matter to the ether by a fundamental law of matter. Consequently, if heat be really a mode of motion, as is now generally supposed by physicists, it follows that there is some essential difference between the character of this motion and the motion of the smallest masses into which matter can practically be divided. The hypothesis of vibration in the fourth dimension merely suggests the possibility that this kind of motion may mark what is essentially different from the motion of masses. Of course, such a hypothesis as this is not to be put forward as a theory. It must be worked out with mathematical rigor and shown to actually explain phenomena before we assign it to any such rank.

I cannot but fear that some confusion on this subject is caused by the tendency among both geometers and psychologists to talk of space as an entity in itself. As I have already said, a fourth dimension in space is nothing more than the addition of a fourth possibility of motion to material bodies. The laws of space are only laws of relative position. Certain fundamental axioms are derived from experience, not alone individual experience, perhaps, but the experience of the race, giving rise to hereditary conceptions born in the mind and corresponding to the facts of individual experience. A tree confined to one spot, even if it had eyes to see and a brain to think, could never have a conception of space. For us the limits of space are simply the limits to which we can suppose a body to move. Hence, when space itself is spoken of as having possible curvatures, hills and hollows, it seems to me that this should be regarded only as a curvature, if I may use the term, of the laws of position of material bodies in space. Clifford has set forth with great acuteness and plausibility that the minute spaces occupied by the ultimate atoms of matter may, in this respect, have properties different from the larger space which alone makes itself known to our conceptions. If so, we should only regard this as expressive of some different law of motion, or, since motion is only change of position, of some different law of position among the molecules of bodies.

This consideration leads us to a possible form of space relations distinct from those of our Euclidean geometry, and from the hypothesis of space of more than three dimensions, I refer to what is commonly known as "curved space." The history of this conception is now so well known to mathematicians that I shall mention it only so far as is necessary to bring it to your minds. The question whether Euclid's axioms of parallels is really an independent axiom, underivable from the other axioms of geometry, is one which has occupied the attention of mathematicians for centuries. Perhaps the simplest form of this axiom is that through a point in a plane one straight line and no more can be drawn which shall be parallel to a given straight line in the plane. Here we must understand that parallel lines mean those which never meet. The axiom, therefore, asserts that through such a point we can draw one line which shall never meet the other line in either direction, but that if we give this one line the slightest motion around the point in the plane, it will meet the other in one direction or the opposite. Thus stated, the proposition seems to be an axiom, but it is an axiom that does not grow out of any other axioms of geometry. The question thus arising was attacked by Lobatchevsky in this very conclusive manner. If this axiom is independent of the other axioms of geometry, then we should be able to construct a self-consistent geometrical system, in conformity to the other axioms, in which this axiom no longer held. The axiom of parallels may be deviated from in two directions. In the one it is supposed that every two lines in the plane must meet; no line parallel to another can be drawn through the same point in the plane. Deviating in the other direction, we have several lines drawn through the point which never meet the given line; they diverge from it as lines on an hyperboloid may diverge.

That such possibilities transcend our ordinary notions of geometrical relations is beyond doubt, but the hypothesis of their possibility is justified by the following analogy. Let us suppose a class of beings whose movements and conceptions were wholly confined to a space of two dimensions as ours are to a space of three dimensions. Let us suppose such beings to live upon or in a plane and to have no conception of space otherwise than as plane extended space. These beings would then have a plane geometry exactly like ours. The axiom of parallels would hold for them as it does for us. But let us suppose that these beings, without actually knowing it, instead of being confined to a plane, were really confined to the surface of a sphere, a sphere such as our earth, for example. Then, when they extended their motions and observations over regions so great as a large part of the earth's surface, they would find the axiom of parallels to fail them. Two parallel lines would be only two parallel great circles, and though each were followed in a direction which would seem to be invariable, they would be found to meet on opposite sides of the globe. The suggestion growing out of this consideration is: May it not be possible that we live in a space of this sort? Or, to use what seems to me to be the more accurate language: May it not be that two seemingly parallel straight lines continued indefinitely would ultimately meet, or diverge? The conceptions arising in this way are certainly very interesting. If the lines would meet, it can

* Address of the president (S. Newcomb) before the American Mathematical Society, December 29, 1897.—From Science.

easily be shown that the total volume of all space is a finite quantity. The sum of the three angles of a triangle extending from star to star would then be greater than the sum of two right angles. Equally legitimate is the hypothesis that it would be less than three right angles; but in this case the total volume of space would still be infinite. Now, this is an hypothesis to be tested by experience. Unfortunately, we cannot triangulate from star to star; our limits are the two extremes of the earth's orbit. All we can say is that, within those narrow limits, the measures of stellar parallax give no indication that the sum of the angles of a triangle in stellar space differs from two right angles. If our space is elliptical, then, for every point in it—the position of our sun for example—there would be, in every direction, an opposite or polar point whose locus is a surface at the greatest possible distance from us. A star in this point would seem to have no parallax. Measures of stellar parallax, photometric determinations and other considerations show conclusively that if there is any such surface, it lies far beyond the bounds of our stellar system.

Such are the considerations by which it seems to me that speculations on this subject may legitimately be guided. The wise man is one who admits an infinity of possibilities outside the range of his experience, but who, in considering actualities, is not decoyed by the temptation to strain the facts of experience in order to make them accord with glittering possibilities. The experience of the race and all the refinements of modern science may be regarded as showing quite conclusively that, within the limits of our experience, there is no motion of material masses in the direction of a fourth dimension, no physical agency which we can assume to have its origin in regions to which matter cannot move, when it has three degrees of freedom. Claiming this, we must carry the claim only to the limits justified by actual experience. We have no experience of the motion of molecules, therefore we have no right to say that those motions are necessarily confined to three dimensions. Perhaps the phenomena of radiation and electricity may yet be explained by vibration in a fourth dimension. We are justified by experience in saying that the space relations which we gather from observation around us are valid for the greatest distances which separate us from the most distant stars. We have no right to extend the conclusion further than this. We must leave it to our posterity to determine whether, in either way, the hypothesis of hyper-space can be used as an explanation of observed phenomena.

ON THE LIQUEFACTION OF AIR AND THE DETECTION OF IMPURITIES (SEPARATION OF HELIUM FROM THE GAS OF THE KING'S WELL, BATH).

By Prof. JAMES DEWAR, M.A., LL.D., F.R.S.

IN a paper on "The relative behavior of chemically prepared and of atmospheric nitrogen," read before the society in the year 1894, it was stated that all samples of nitrogen and oxygen properly purified are, when liquefied, clear transparent liquids, so that the solid matter which always separates when air or nitrogen or oxygen is liquefied on the large scale consists of impurities. Ordinary air containing 4 parts of carbonic acid per 10,000 parts gave a turbid liquid from the solidification of the carbonic acid; and oxygen containing traces of chlorine behaved in a similar manner. With the object of ascertaining the proportion of any gas in air that is not condensable at about —210° C. under atmospheric pressure, or is not soluble in liquid air under the same conditions, the following apparatus has been devised. A cylindrical bulb of a capacity of 101 c. c., marked B in figure, had a capillary tube sealed into it terminating in a threeway stopcock, as shown at E. The parts marked C and D consist of soda lime and sulphuric acid tubes for removing carbonic acid and water. The stand marked G holds the large vacuum test tube into which B is inserted which holds the liquid air maintained under continuous exhaustion. As this low temperature had to be kept steady for from one to two hours, while at the same time the bulb, B, had to be completely covered with liquid air, it was necessary to arrange some means of keeping up the liquid air supply without disturbing the apparatus. The plan adopted is shown at H, which is a valve arrangement which can be so regulated as to suck liquid air from the large vacuum vessel, A, and discharge it continuously along a pipe into the vacuum test tube, G, the latter being kept under good exhaustion. In working the apparatus, the tube, I, is connected to a gasometer containing 10 cubic feet of air, so that the volume of air condensed in each experiment may be observed. This was generally from 2½ to 3 cubic feet. If there is a very small proportion of some substance not liquefiable or soluble in liquid air, then we should expect the vessel, B, would not fill up completely into the capillary tube. This is, however, exactly what does take place. After 40 minutes' cooling the vessel, B, and the cool part of the tube were filled with liquid. In this experiment some 80 liters of air were condensed, and any accumulated uncondensed matter must have been concentrated in the upper part of the capillary tube, which had a volume of 0·5 c. c. Under the conditions, therefore, the material looked for must be less than 1 part by volume in 180,000 of air.

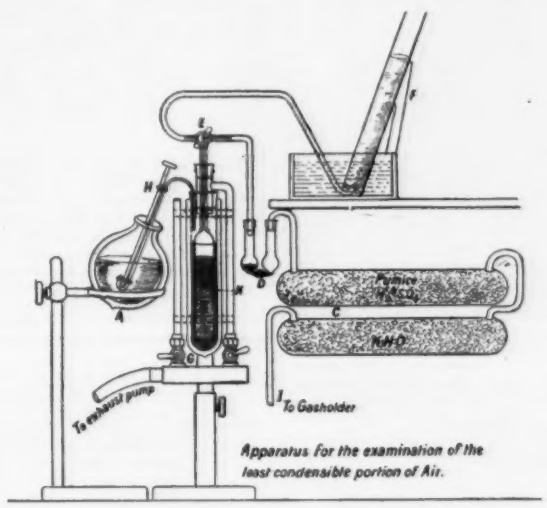
To test the working with an uncondensable gas added to air, a volume of 10 cubic feet was taken in the gasholder and to that 500 c. c. of hydrogen were added. This is in the proportion of less than 1 in 500. Even after two hours' cooling, the tube, B, could only be filled four-fifths. In order to prove that the gas accumulated in the upper part of B was hydrogen, the threeway stopcock at E was turned, and the temperature allowed to rise so that the gas was expelled from the evaporation of the liquid air and collected over mercury as shown at F. The gas thus collected was easily combustible and consisted chiefly of hydrogen. The amount of hydrogen was then reduced to 1 part in 1,000 of air, and it was found that after one and a quarter hours' cooling the bulb, B, had filled to within a half c. c. of the capillary tube. A new sample of air containing 1 part of hydrogen in 10,000 of air filled the bulb, B, completely as if it were ordinary air.

It appears from these experiments that 1 part of hydrogen in 1,000 of air is just detectable by this plan of working. As the 80 liters of air condensed contained some 80 c. c. of hydrogen, it appears that 100 c. c. of liquid air at from —200° to —210° C. had dissolved nearly all this gas; in fact, that 20 c. c. of hydrogen at the low temperature is dissolved in 100 c. c of liquid air. In the paper on "The liquefaction of air and research at low temperatures" (Proc., 1895, 11, 221), it was shown that if hydrogen containing a small percentage of oxygen were employed for the purpose of getting a hydrogen jet, the liquid collected from it was oxygen, containing, however, so much hydrogen dissolved in it that the gas coming off for a time was explosive.

In order to press this inquiry a little further, some natural gas known to contain a different constituent, like helium, suggested itself as being worthy of trial. Lord Rayleigh's results of the examination of the gas from the King's Well at Bath showed that it contained 1·2 part of helium per 1,000 volumes, so that it seemed admirably adapted for such experiments. The author has to express his thanks to the corporation of Bath for giving permission to collect samples of the gas.

The sample of gas from the Bath Spring was treated exactly in the same way as the hydrogen mixtures described above. During the liquefaction there was a marked difference in the appearance of the liquefied gas, for while the hydrogen and air mixtures gave a clear, transparent liquid, the product from the Bath gas was turbid, and the precipitate by transmitted light looked yellow-brown. This solid turns out to be of organic origin, probably of the petroleum order of compounds. It has a very marked aromatic smell resembling such bodies. The trace of material left gave, after treatment with concentrated nitric acid, the smell of nitrobenzene; and as its detection cannot be explained by the presence of any material of the kind in the vessels used in collecting, it must be assumed to be a normal constituent of the Bath gas. A further quantity of the Bath gas must be collected in order to confirm the presence of such bodies and to definitely make out their nature. Another peculiarity of the liquid is that, on examining it with the spectroscope, even through a thickness of two inches, no trace of the characteristic oxygen absorption spectrum could be detected. In all attempts to make nitrogen for liquefaction on the large scale, oxygen could always be detected in the liquid with the greatest ease by means of its absorption spectrum. After the cooling had continued for one hour the gas ceased to flow into the condensing vessel, and some 20 c. c. at the upper part of the glass cylinder, B, was filled with a gas that had not undergone liquefaction or solution. About 70 liters of the Bath gas were condensed, certainly the largest quantity of this gas ever subjected to chemical examination. This was boiled off just as the hydrogen was treated in the experiments described above, and as, by accident, too much nitrogen had volatilized along with the gas, oxygen was added and the mixture sparked over alkali to get rid of the excess of nitrogen. During the sparking, the helium lines were well marked (along with others the origin of which must be settled later), and a vacuum tube filled with the product of the sparking gave a splendid spectrum of the gas. The sample of gas directly connected from the liquid nitrogen contained about 50 per cent. of helium. It is therefore possible to separate helium from a gas when it is only present to the extent of one-thousandth part by liquefaction in the manner described. From this it would appear that helium is less soluble in liquid nitrogen than hydrogen is in liquid air, and is of greater volatility than either of the constituents of air, as Prof. Olszewski found (Bull. Ac. Crac., 1896, 297) by direct experiment on a pure sample of the gas sent to Cracow by Prof. Ramsay with the object of liquefaction. In the author's lecture (Proc. Roy. Inst., 1896), entitled "New researches on liquid air," the following observation occurs: "The exceptionally small refractive value observed by Lord Rayleigh in the case of helium shows that the critical pressure of this body is proportionately high. It would therefore be more difficult to liquefy than a substance having about the same critical temperature but possessing a lower critical pressure than hydrogen." Now that it has been shown by Prof. Moissan and the author that two substances like fluorine and argon, differing by 2 units in molecular weight, boil at nearly the same temperature, it seems reasonable to extend the analogy to the case of hydrogen and helium, where the same difference occurs, and to suggest that they also probably have about the same volatility: If the sample of uncondensed gas resulting from the first liquefaction of the Bath gas were again treated in the same way, a much more concentrated specimen of helium could be obtained. Provided helium were wanted on a large scale, then a liquid air apparatus similar to that in use at the Royal Institution transported to Bath and worked with the gas from the King's Well could be made to yield a good supply. With a modified form of apparatus, it will be possible to collect any residuary gas from the use, not of 3 cubic feet of air or Bath gas, but from hundreds of cubic feet of such products. This investigation will be continued with new samples, in order to see if the composition of the gases changes and to isolate the hydrocarbons.

The author has to thank Mr. Lennox and Mr. Heath for able assistance in carrying out the experiments.



Apparatus for the examination of the least condensible portion of Air.

MODERN ALCHEMY.

By W. E. ORD, B.A.

A LOVE of science for its own sake has been the noblest incentive of the world's greatest discoverers, but in the pursuit of chemical science there has ever been an inducement of a more practical kind. We find the alchemists of old continually urged forward in their arduous labors by the dreams of wealth which their science, if it could be so called, appeared to render capable of realization; or perhaps by the infinite possibilities which seemed to exist in the changing substances around them. In mediæval times, when the European world was throbbing with the excitement occasioned by the discovery of untold wealth in the New World, when adventurers were giving their lives in the vain endeavor to become rich at a stroke, the alchemists in their laboratories were scarcely less eager in their investigations, impelled by that dream of wealth which never fails to rouse the dormant energies of mankind. Strange as the hope of the alchemists may seem to us, the idea of transmuting the baser metals into gold appeared, with the knowledge of chemistry then possessed, to have a plausible foundation of fact. In the view of the alchemists, the baser metals could have none of that stability of character with which the pure elements are now associated. Examined in an impure state, they were changeable in their properties, and often unrecognizable, for a minute trace of impurity alters their character. A trace of lead or arsenic, for example, renders gold exceedingly brittle and alters its color; while, as is well known, a small quantity of carbon in iron causes it to become elastic, and if more be present, it becomes hard and brittle.

In addition to this instability of character, the transmutation had every appearance of possibility under the view then generally accepted—and first taught by Geber, an Arabian chemist—that all the metals were alloys of sulphur and mercury in varying proportions, their various properties being produced by the existence of a great or less quantity of either of these elements. The noble metals were held to be particularly rich in mercury and poor in sulphur, and the transmutation of the baser metals was thought to consist in the withdrawal of sulphur from them and the addition of mercury. The difficulties and confusion which the alchemists had to contend with were still further increased by the spirit of mysticism pervading their writings, and the consequent impossibility of following up the discoveries of previous investigators. In view of such difficulties, it is not surprising that, though a belief in alchemy lingered on into the last century, the alchemists should have been a long way from finding the true path to a process of transmutation which is still regarded by many as undiscoverable.

Within the past year a claim has been made to the discovery of a solution of the problem of the alchemists which is both startling and interesting. Dr. Emmens, an eminent chemist of New York City, and inventor of the high explosive "emmensite," has recently published an account of some researches which would seem to have resulted in the actual transmutation of silver into gold—an achievement as important in its economic aspect as it is revolutionary with regard to chemical theory. In order, however, to properly appreciate the work which appears to have been accomplished, it is well first to consider the subject in the light of modern chemistry. The chemist, in pursuing his analyses of matter as far as his methods will permit, discovers that there are some seventy kinds of substances which refuse to be split up into other substances, and to these ultimate constituents of matter he gives the name of "elements." To the elementary bodies he finds, by reason of certain considerations which cannot now be gone into, that different numbers, representing the ratios of the weights of their respective atoms, may be attached, and thus we obtain a series of elements with atomic weights, ranging from that of hydrogen to those of the heaviest elements known. It is, moreover, found (as was first observed by Newlands in 1864) that if the elements are arranged in the order of their atomic weights, similar elements recur at definite intervals in the series. Thus they arrange themselves in several groups or "natural families," and the properties of the elements are said, mathematically, to be periodic functions of the atomic weights. In view of the problem of the transmutation of the metals (which are elementary bodies) this classification is supremely interesting. As it is found that certain elements are more nearly

related to those in the same group than to others, their transmutation, in the large number of such cases occurring, into a nearly related element may be a problem which it is worth while to attack. Another consideration, moreover, is that, as the properties of an element depend upon its atomic weight, the elements, especially of one family, may possibly be regarded as built up from one another, or from some common material. Whatever relation among the elements this periodic classification may really indicate, it is probable that it has its origin in some unknown law concerning their formation; and it must be admitted that the hope of the alchemists, resting in their own time upon entirely false hypotheses, may, with the progress of chemistry, find its realization in some new field of modern investigation.

It is by means of the classification referred to that important suggestions were obtained which resulted in Dr. Emmens' startling discovery. As he himself describes it, his work had its origin in an attempt to prepare absolutely pure iron and pure nickel. In his investigations he obtained a new substance from iron and nickel different from anything before observed, and this substance was afterward obtained in a similar manner from the element cobalt. Here, therefore, a substance is found which appears to be common to one of the groups of the elements, and, in itself, such a discovery is one of the greatest moment. Dr. Emmens has, however, proceeded to apply his method of investigation in another direction, and having regard to the fact that the gold and silver group offered the greatest reward to his labors if successful, he applied the same investigation to the series containing copper, silver and gold.

It was previously known that silver could be made to pass into solution in water while still in a metallic condition, and it is considered that the element is, in this soluble form, reduced to extremely minute subdivisions. If such a process could be pushed further, the silver molecules, or smallest particles of silver as such, would become dissociated; and, as is observed in other cases, the body obtained exhibits new and remarkable properties. This further subdivision eventually succeeded in the case of silver, and a substance was produced which, in the opinion of Dr. Emmens, can no longer be regarded as the same element.

With this substance, moreover, a step further can be taken. It was found possible to group the new substance into molecules of greater density than those of silver, and, in fact, to produce a new body which exhibited entirely different properties. It was yellow by reflected and green by transmitted light, and it was insoluble in either hydrochloric or nitric acid alone, but soluble in aqua regia, a mixture of these acids—thus possessing the characteristic properties of gold. It also resembled gold under the microscope.

The method of procedure has not yet been made known, but an actual transformation of one element into another is claimed to have been effected, and the claim is made by a chemist of scientific eminence and the author of several scientific works. The process is stated to depend upon mechanical treatment, and it is suggested that use may be made of the combined effect of impact and a very low temperature.

It is startling to consider what a wide field of investigation such a transformation opens up, and it suggests that a scientific problem generally regarded as insoluble may be successfully attacked when approached on entirely new lines. It does not seem improbable that several transmutations may, in reasonable time, be successfully accomplished; for we have little ground for regarding the elements as the ultimate particles of matter, except our inability to split them up further. But such inability may with future discoveries be overcome. At one time the alkalies, potash and soda, were substances which could not be decomposed, until Davy, with the galvanic current, separated from them the elements potassium and sodium. By analogy, we may regard the elements of modern chemistry as substances whose analysis resists the action of all known forces. Their formation in nature in the earlier stages of the world's history may have involved forces hitherto undreamed of by mankind; and who therefore can say what startling effects may result in the application of new conditions or of forces yet to be discovered?—Knowledge.

A valuable communication in Dingler's Polytechnisches Journal, by Hans Gunther, takes the ground that the objectionable efflorescence which makes its appearance on brick and sandstone structures may come from the clay, the water employed during the various stages, the ashes and pyrites of the coal, and from the mortar. The pyrites of the coal, he remarks, may certainly cause mischief, especially because practice is commonly in favor of continuous ring kilns, which work with plenty of oxygen, while in the old periodical kilns the atmosphere was so frequently reducing that but little sulphuric acid was formed. Again, the presence of sulphuric acid favors the production of red colored bricks, for it decomposes the yellow iron lime silicate. More importance, however, is attached by Gunther to the pyrites in the clay, and to chemical interaction between brick and mortar. In pursuing the latter inquiry he found that certain bricks remained quite smooth when piled up, and soon became covered with efflorescences when used with a mortar that proved perfectly harmless to other bricks. Almost all clays contain pyrites, which, in the presence of magnesia, give rise to immediate efflorescences; but in the presence of lime only after decomposition with the alkalies of the mortar.

The dahlia is a Mexican flower, which, as grown in the gardens of Mexico, captivated Hernandez, who visited the country in 1615, and mentions two species, one with pale red flowers, which grew wild in the mountains of Quanhuahuac, and was called "acocetli." Over a century later M. Thierry Menonville, who was sent to Mexico to steal the cochineal insect from the Spaniards, describes the dahlia with admiration. The first seeds were brought to Madrid in 1788, and planted in the botanic garden of the city, where the plants flowered in October, 1789. Lord Bute obtained some of these seeds, and planted them in England, where the plant flowered in 1790. The modern name comes from Dahl, the Swedish botanist. The dahlia did not thrive in England till Lady Holland sent more seeds from Madrid, in 1804

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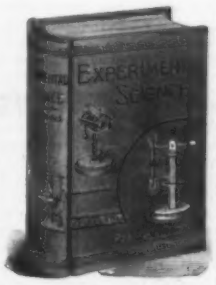

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